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RIDEAU RIVER STORMWATER MANAGEMENT STUDY

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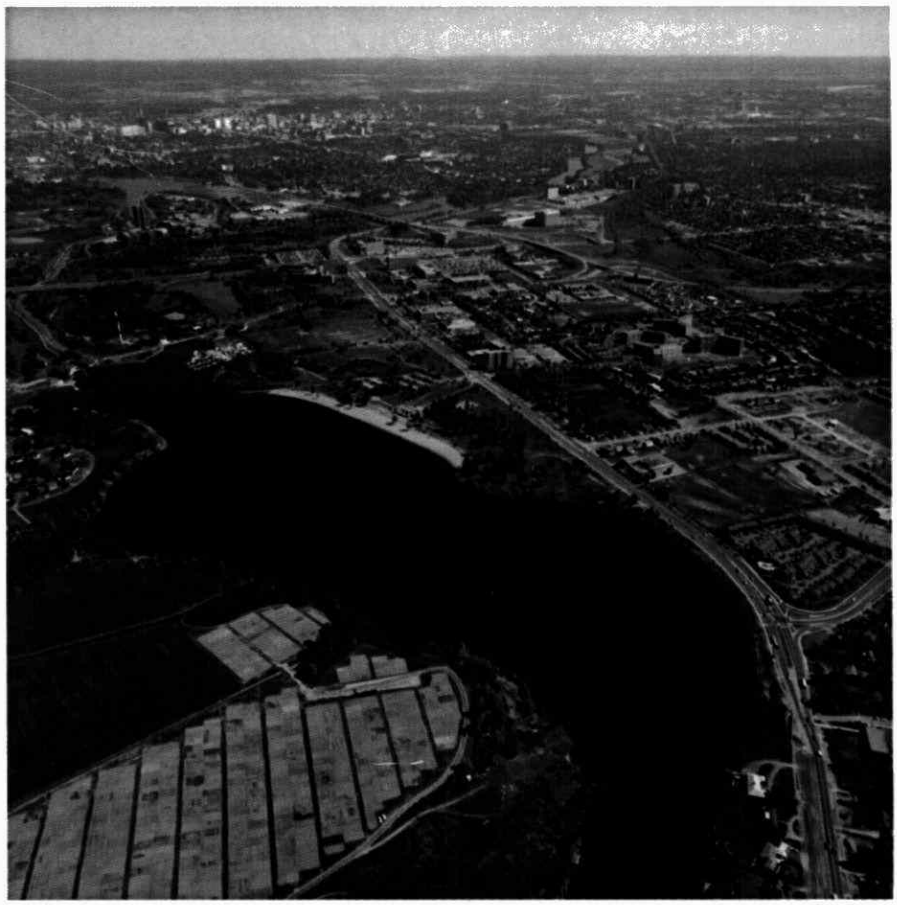

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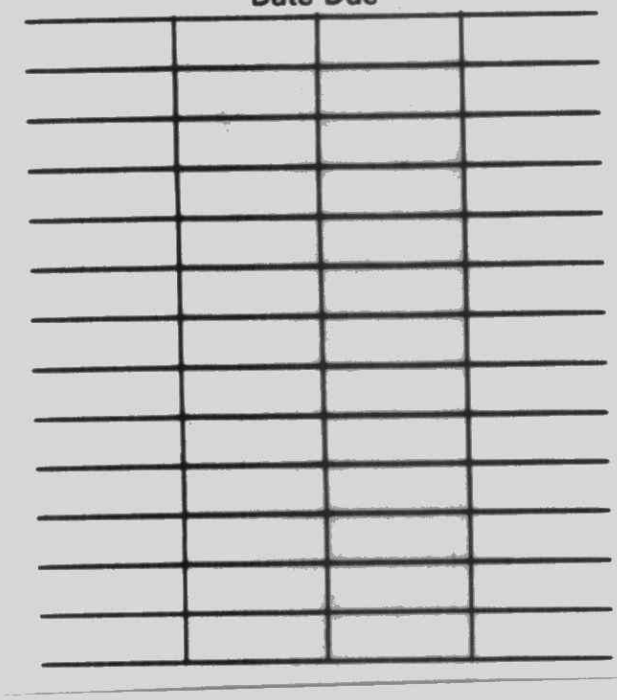

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RIDEAU RIVER STORMWATER MANAGEMENT STUDY

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Nepean

1983

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FOREWORD

The Rideau River Stormwater Management Study (RRSMS) commenced in June 1979 as a cooperative effort of the Ontario Ministry of the Environment, Environment Canada, the Regional Municipality of Ottawa-Carleton, the City of Ottawa and the City of Nepean with major funding provided by the Provincial Lottery Trust Fund.

The goal of the Study was to develop a cost-effective stormwater management strategy which would improve the quality of water in the lower Rideau River and permit a wider range of recreational uses on the river, in particular swimming. It would also recommend the measures necessary to ensure that urban development in the upstream areas in the Regional Municipality of Ottawa-Carleton below the Village of Manotick would not degrade the water quality. Beaches in the lower reach of the river in the City of Ottawa were closed in 1970 as the bacteriological water quality did not meet the Ministry of Health's standards for body contact recreation.

This report contains a summary of all projects and investigations undertaken by participating agencies, consultants and study staff. Technical aspects were guided by a Technical Committee and various sub-committees, while financial control and general study direction were provided by a Study Steering Committee (see Appendix A) consisting of representatives from:

* * Ontario Ministry of Environment
* * Environment Canada
* * Regional Municipality of Ottawa-Carleton
* * City of Ottawa
* * City of Nepean
  City of Gloucester
  Ontario Ministry of Natural Resources
  Rideau Valley Conservation Authority
  National Capital Commission
  Ottawa-Carleton Regional Health Unit

Chapter 1 contains a synopsis of the problem and the recommended pollution control and implementation strategy. Chapter 2 reviews the historical background to the Study, lists the terms of reference and describes the Study approach. Chapter 3 summarizes the general water quality of the Rideau River; Chapter 4 the sources of bacterial pollution and Chapter 6 the pollution control measures and their costs. Chapter 5 highlights water quality goals and recreational opportunities.

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* sponsoring agencies

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SOMMAIRE

Une étude du cours inférieur de la rivière Rideau, dans la municipalité régionale d'Ottawa-Carleton, a été réalisée en vue de déterminer les causes de la dégradation bactérienne de la qualité de l'eau sur les rives urbaines et en vue de protéger les eaux de la rivière contre les incidences de l'urbanisation future pour qu'elles puissent continuer d'être utilisées à des fins récréatives. Actuellement, plusieurs plages du secteur urbain sont fermées à cause de la contamination bactérienne. La plage de Mooney's Bay demeure ouverte, mais elle risque d'être contaminée suite aux activités futures d'urbanisation.

Les sources de pollution bactérienne ont été déterminées par temps sec et par temps pluvieux. Diverses mesures de contrôle ont été évaluées en vue de satisfaire à l'objectif provincial de la qualité de l'eau pour la baignade et la natation.

Un plan de lutte contre la pollution pour toute la portion urbaine du cours d'eau dans les limites de la ville d'Ottawa est recommandé. Le plan porte principalement sur la solution des problèmes causés par les sources locales de pollution par temps sec. En outre, la mise en oeuvre de mesures visant la réduction de la pollution bactérienne dans les eaux de ruissellement est recommandée.

Une stratégie de lutte contre la pollution pour le secteur urbain en amont des plages actuelles a été élaborée afin d'empêcher toute détérioration de la qualité de l'eau suite à l'urbanisation. Il est recommandé que tous les nouveaux aménagements urbains comprennent des installations pour le controle de la qualité des eaux pluviales pour limiter la pollution causée par les eaux de ruissellement et ainsi, maintenir la qualité de l'eau de la rivière Rideau.

ABSTRACT

A study of the lower Rideau River in the Regional Municipality of Ottawa-Carleton was conducted to establish the causes of bacteriological water quality degradation in the urbanized reach and to protect the river's use for body contact recreation from impacts of future urbanization. At present, several beaches in the urbanized area are closed due to bacterial contamination. While the beach at Mooney's Bay remains open, it is considered in danger of contamination from future urbanization.

The sources of bacteriological pollution were determined under dry weather conditions and during rainfall events. Various control measures were evaluated to meet The Provincial Water Quality Objective for swimming and bathing use of water.

A pollution abatement plan for the fully urbanized reach within the City of Ottawa is recommended. This plan is focussed initially at correcting local dry weather sources of pollution. In addition, measures to reduce bacteriological pollution in urban stormwater runoff are recommended for implementation.

A pollution control strategy for the urbanizing reach upstream of existing swimming areas was developed to prevent any deterioration of water quality as a result of urbanization. It is recommended that stormwater quality controls be included in all new urban developments to control runoff pollution and thus maintain bacteriological water quality in the Rideau River.

1. SUMMARY AND RECOMMENDATIONS

1.1 SYNOPSIS

BACKGROUND

The Rideau River is valued and recognized as a unique resource in the Nation's Capital for boating, swimming and other water oriented recreational activities. In the early 1970s concern was expressed by the Medical Officer of Health about the bacteriological quality of the River for swimming and, subsequently, several of the beaches in the urban area were closed.

The Regional Municipality of Ottawa-Carleton (RMOC) and the constituent municipalities launched an extensive program of "search and destroy" to locate and remove pollution sources. Initially, many sources consisting mainly of cross-connections between sanitary sewers and stormwater sewers were found and corrected. Bacteriological water quality improved but swimming standards were not reached. Cross-connections were still uncovered but in lesser numbers. Hence other sources of pollution were suspected.

By 1976, the Ministry of the Environment had determined that positive steps should be taken to protect water quality and adopted a policy that there should be no further degradation from future urban development in the area. It was also recognized that since the lower reach of the river was almost completely built up, remedial measures would have to be taken if the water quality objectives of the Ministry were to be met.

The bacteriological quality of the water which largely determines the River's potential for body contact recreation, deteriorates in a downstream direction as urbanization increases. The Mooney's Bay area, intensively used for swimming and other non-contact sports meets the

swimming standard of 100 fecal coliforms/100 mL most of the time (on average: 93% of the time during the summer months). Only major rain storms over the area cause violations of the standard. However, the water quality quickly deteriorates downstream of Hog's Back to such an extent that below Bank Street the swimming standard is almost never achieved and the beaches at Brighton, Brantwood and Strathcona have remained closed since 1970.

POLLUTION SOURCES

At the start of the Rideau River Stormwater Management Study, the following pollution sources were known to exist although they were largely unquantified:

- combined sewer overflows,
- urban stormwater runoff, and
- feces from birds on bridges.

The Study quantified these sources and identified additional sources along the lower Rideau thought to originate from directly connected sanitary sources, leakages from the sanitary sewers (exfiltration) and cross-connections between storm and sanitary sewers. These sources were shown to exist between Carleton University and Windsor Park and also below the Queensway to such an extent that swimming criteria could generally not be met most of the time in the River below Bank Street. A program to restore the Rideau River below Hog's Back to a state in which it could be used for swimming must therefore necessarily start with a program to locate and to eliminate these pollution sources.

A program of sewer separation in the City of Ottawa which was started in 1971 had been accelerated in 1975. Out of six overflows in operation when the Study commenced, only two overflows remain active at present, both upstream of Strathcona beach. The complete elimination of overflows to the River is a pre-requisite before swimming will be allowed at this beach.

Natural controls in the River below Hog's Back form a number of deep reaches resulting in a very slow exchange of water. Thus, urban runoff high in microbiological pollution will not be flushed out immediately after a storm but will linger for a number of days thereby causing elevated levels of fecal coliforms for a longer time than normal in a fast flowing river. This problem is exacerbated by runoff from the largely impervious area in the City caused by many small and frequent storms which occur on average once every three days during the summer period.

In the upper portion of the Study area, in contrast, most of the area is undeveloped land, primarily in agricultural use. This type of land provides no significant contribution of runoff or pollution load during a typical average rainfall (7 mm). However, if controls are not implemented as the area urbanizes, it can be expected that degradation of water quality may occur in the future resulting in an increase of the percentage of time that the swimming standard would be exceeded. Effective stormwater management is thus required to control pollution loadings resulting from urbanization.

Pollution profiles along the lower Rideau established by the RMOC starting in 1978 indicated that birds on bridges were a potential source of pollution. This Study established that feces from pigeon populations on bridges alone are sufficient to raise the River's fecal coliform density to the swimming standard and, hence, bird populations must also be controlled if swimming is desirable.

DEVELOPED URBAN AREAS

Locating sources of pollution in an older urban area with an aging sewer system, let alone correcting problems after they are found, is a monumental task, the extent of which in terms of effort, cost and success can not be estimated with any great degree of certainty. Therefore, such a program should be implemented in three phases for maximum efficiency in a downstream direction starting with the reach from Hog's Back to Brewer Park.

If it appears that correction of these sources is technically or economically infeasible, the River could be isolated from any direct inputs of stormwater and groundwater by building an interception sewer along both sides to collect and treat the water before being discharged to the river.

The bacteriological quality of the River has been satisfactory in most years near Brewer Park although the impact of the Carleton University complex can be observed in River water quality. After the sanitary leakages are successfully abated as determined from continued instream monitoring and the bird population on Bronson Avenue bridge is controlled, the water quality near Brewer Park is expected to be acceptable for swimming most of the time.

The cost of reducing fecal coliform densities in the River to meet swimming standards increases substantially downstream of Brewer Park since, in addition, control of urban stormwater runoff is required. This is expensive in a built-up urban environment and, hence, alternatives to swimming in the Rideau River should be evaluated.

DEVELOPING SUBURBAN AREAS

Stormwater quality controls in the form of retention ponds have been incorporated in developing areas upstream. These ponds have been designed on the basis of quiescent settling of suspended sediments and attached bacteria before the water is discharged to the Rideau River. Most of the ponds have been built as end-of-pipe units before stormwater is allowed to flow into the Rideau River.

A major effort was undertaken by the RMOC to investigate one particular pond, Kennedy-Burnett in Barrhaven, Nepean. The effectiveness of quiet settling of urban runoff was demonstrated; over 95% of the pollutant load for suspended solids, total phosphorus, fecal coliforms and fecal streptococcus were removed for most storms after 2 or 3 days of retention. Much remains to be learned about bacterial population dynamics and ecology in stormwater runoff and treatment although immediate practical results have been achieved.

1.2 POLLUTION CONTROL STRATEGY

Major emphasis was placed on water quality impacts of urban runoff on the Rideau River as the receiving water and its effect on its recreational potential. A review of information at the start of the Study concluded that the only significant impact from the urban area was from increased fecal coliform loads to the River. Therefore, the pollution control strategy suggested below will essentially only deal with bacterial impacts. It should be recognized however, that by controlling fecal coliform loads to the receiving water, a number of other pollutants such as suspended solids, heavy metals and phosphorus will be reduced.

The pollution control strategy developed recognizes the desire for maximum recreational use of the River and in particular for swimming throughout its length. Since the two reaches of the River respectively below the above Hog's Back are distinctly different in terms of water quality, a control strategy has been developed for each reach.

RIDEAU RIVER BELOW HOG'S BACK

The major effort should initially be directed towards correcting local pollution sources including those that might originate from leaks in the sanitary sewers, directly connected sanitary sources and cross-connections between sanitary and storm sewers, before other measures to reduce wash-off pollutants by stormwater runoff can be implemented.

The extent of the problem in terms of effort, cost and success cannot be estimated with any great degree of certainty. Therefore, such a program should be implemented in phases for maximum efficiency in a downstream direction, thus providing for a flexible and cost-effective approach towards re-opening beaches.

IT IS RECOMMENDED:

1. THAT A POLLUTION ABATEMENT PROGRAM BE CARRIED OUT CONSISTING OF

   a) THE ELIMINATION OF LOCAL POLLUTION SOURCES WHICH MAY INCLUDE:
      - LEAKAGES FROM SANITARY SEWERS (EXFILTRATION);
      - DIRECTLY CONNECTED SANITARY SOURCES; AND/OR
      - CROSS-CONNECTIONS BETWEEN SANITARY AND STORM SEWERS

   b) CONTROL OF PIGEONS ON BRIDGES; AND

   c) CONSTRUCTION OF FLOW INTERCEPTORS AND TREATMENT DEVICES

   IN THREE PHASES AS FOLLOWS:

   PHASE I - HOG'S BACK TO BREWER PARK
   PHASE II - BREWER PARK TO CLEGG STREET
   PHASE III - BELOW CLEGG STREET

This program has been estimated to cost:

PHASE	BEACHES		
	Name	Length(m)	Incremental Cost
I	Brewer Park (***)	250	$ 128,000 (1,323,000)*
II	Brighton	50	$ 4,187,000
	Brantwood	150	$ 1,510,000
III	Strathcona	125	$ 5,810,000 (**)
TOTAL			$11,635,000 (12,835,000)*

* including $1,200,000 for flow interceptors and treatment if control of leakages are ineffective or more expensive.

** including $1,500,000 as an apportioned cost for water quality control to eliminate combined sewer overflows.

*** development cost of beach excluded.

Phase I - Hog's Back to Brewer Park

The cost of control to a level satisfactory for swimming up to Brewer Park is relatively small (control leakage from Carleton University's sanitary sewers and pigeons on bridges) compared to the total cost for the entire lower Rideau, which includes also the control of stormwater runoff.

The bacteriological quality of the River has been satisfactory in most years near Brewer Park although the impact of the Carleton University complex can be observed in River water quality. Blockages in a sanitary sewer system at the Carleton University campus have shown that the sanitary sewer caused seepage to a storm sewer. As a corrective measure the storm sewer was lined with a plastic pipe preventing sanitary sewage from entering the storm sewer. However, the source has not been eliminated and it must therefore be concluded that waste water finds its way through the ground to the River.

Bird populations on the bridges upstream of Brewer Park should also be controlled to reduce violations of the swimming standard. At times, swimming standards would be exceeded because of transient elevated fecal coliform levels after a rainfall. Therefore, a water quality forecasting model should be developed so that beach closings may be kept to a minimum.

Diversion and/or treatment of stormwater runoff is not expected to be required if sanitary leakage can be successfully abated as determined from continued instream monitoring. If these leakages can not be rectified, an interceptor and diversion sewer may need to be constructed at an estimated cost of $1,200,000 to prevent sanitary waste from leaking to the river.

Phase II - Brewer Park to Clegg Street

The calculated load of fecal coliform to the river in dry weather was shown to increase just upstream of the Bank Street bridge (Figure 10). Efforts should initially be concentrated in this area.

Further downstream, Sawmill Creek enters the Rideau River. Fecal coliforms and Pseudomonas Aeruginosa are elevated in dry weather. Sanitary surveys should be intensified to locate and thereafter to correct the sanitary waste sources (Recommendation 1a).

A study of the Sawmill Creek basin was recently completed for the City of Ottawa, the National Capital Commission and the City of Gloucester. This study addressed water quantity and water quality aspects related to existing and further development of the catchment and as such may be considered as a master drainage plan for the entire basin. Fecal coliform criteria to meet bathing standards were specified at the mouth by the RRSMS and a plan evolved which included controls at various locations in the catchment. The suggested controls should be considered as part of Phase II. (Cost shown includes $1 million for Sawmill CK)

The proximity of the Clegg Street combined sewer outfall to Brantwood beach has raised concerns as to the possible impact on water quality at this beach. Preliminary investigations indicated that the possibility of backflow is small. Detailed surveys should be undertaken as part of the Phase II program.

Phase III - Below Clegg Street

The Glebe area to the west of the Rideau Canal and a smaller area near Springhurst are still being served by combined sewers discharging to the Rideau River. Both overflows are located upstream of Strathcona Beach. Hence, these overflows must be closed before swimming will be considered at Strathcona.

It has been observed from many years of regular sampling at Strathcona Beach below the Queensway by the Ottawa-Carleton Regional Health Unit, that typically densities of fecal coliforms increase during the summer as flows in the River decrease, thereby pointing to a fairly constant source(s) discharging to the River at or below the Queensway bridges.

The major focus of the pollution control strategy is to prevent any deterioration of water quality as a result of urbanization. Stormwater quality controls are therefore required in all new developments and re-developments and these controls should be integrated into the subdivision plan.

Two pollution control scenarios were investigated for protecting the recreational potential of the river compared to a do-nothing situation:

1. Controls for protection of the Mooney's Bay area only
2. Controls to protect the entire reach from Long Island to Mooney's Bay.

Impacts from all catchments on the fecal coliform levels at selected locations were investigated (Report 23).

In summary, it was concluded that catchments located inside the Greenbelt only (see map) appear to have a significant effect on the water quality at Mooney's Bay. The travel time from developing catchments beyond the Greenbelt are long and consequently the effects at Mooney's Bay are minimal. Hence, to protect swimming at Mooney's Bay, controls inside the Greenbelt are required and controls outside the Greenbelt would not be necessary (scenario 1).

Most of the future development will take place outside the National Capital Commission's Greenbelt lands with a number of smaller areas inside the Greenbelt. If water quality controls outside the Greenbelt are not implemented existing river water quality near the new developments would degrade; a situation not consistent with Ministry of Environment goals and objectives.

In addition, the City of Ottawa is considering developing a new bathing facility (Uplands) along the Rideau River just below the Black Rapids' dam. Therefore, to protect this site and the interests of residents living along the Rideau River consistent with Ministry of the

Environment goals, control of the entire reach of the river is desirable. The approximate cost of future controls to meet requirements for scenario 2 in the upper reach are:

RIVER REACH	COST ($)
Mooney's Bay - Black Rapids	1,200,000
Black Rapids - Long Island	8,500,000
TOTAL	9,700,000

An agreement was reached between the City of Ottawa and the Ministry of the Environment before approval was granted to develop the Western Community, Phase III. Design of a facility is now in progress. Therefore,

2. IT IS RECOMMENDED THAT A STORMWATER MANAGEMENT FACILITY BE CONSTRUCTED ON UPLANDS CREEK CONSISTENT WITH THE OBJECTIVE OF NO FURTHER INCREASE OF BATHING STANDARD VIOLATIONS AT MOONEY'S BAY.

A special structure at a cost of $160,000 was provided at the Colonnade superpipe (oversized sewer) outlet to the river to provide some form of pollution reduction by means of storage. The structure has not been operated to date nor has any assessment been made of its effectiveness. Therefore,

3. IT IS RECOMMENDED THAT THE COLONNADE SUPERPIPE OUTLET STRUCTURE BE OPERATED SO AS TO ACHIEVE MAXIMUM POLLUTION LOADING REDUCTIONS.

In addition to stormwater management ponds, various other means are available to reduce the impact of increased bacterial loads from new developments. These aspects should be addressed in a master drainage plan for an entire sub-catchment or for large areas such as the Jock River and Mosquito Creek. Details should be considered at the subdivision design level. Therefore,

4. IT IS RECOMMENDED THAT MASTER DRAINAGE PLANS BE PREPARED OR REVISED FOR DEVELOPING DRAINAGE BASINS INCORPORATING STORMWATER QUALITY CONTROLS CONSISTENT WITH THE OBJECTIVE OF NO FURTHER DETERIORATION OF WATER QUALITY.

Control of rainfall events up to 25 mm effectively minimizes the impact of urban development on the Rideau River. Design guidelines should be prepared which include the allowable release rates and fecal coliform densities from future developing areas. New stormwater treatment facilities should be designed using the pond performance data from the Kennedy-Burnett facility and data from future monitoring of other facilities already in place. Therefore,

5. IT IS RECOMMENDED THAT THE REGIONAL MUNICIPALITY AND THE ONTARIO MINISTRY OF THE ENVIRONMENT, JOINTLY

a) ESTABLISH OPERATING AND COMPLIANCE CRITERIA FOR ALL EXISTING STORMWATER MANAGEMENT FACILITIES: AND

b) PREPARE TECHNICAL GUIDELINES FOR THE DESIGN OF STORMWATER MANAGEMENT FACILITIES TO ACHIEVE COST-EFFECTIVE POLLUTION CONTROL.

Further development in the South Urban Community (Catchments 23-27, see map) has not been approved other than about 160 ha west of the existing development in Barrhaven, known as Cedarview. This area is adjacent to the sub-catchment being controlled by the Kennedy-Burnett pond. Quality control by the Kennedy-Burnett facility appears more than necessary from the analyses carried out, and, hence, additional water quality control in the Cedarview subdivision may not be required. However, this aspect should be resolved in a stormwater management plan.

Whenever planning proceeds for the South Urban Community, the Master Drainage Plan prepared in 1977 should be updated to take into account the results of this study and future advances in the state-of-the-art.

Most of the development in the City of Nepean will occur in Catchments 26 and 27 in the lower Jock Basin; development in the City of Gloucester is concentrated in Mosquito Creek Basin (Catchment 24). Specific water quality control criteria should then be derived incorporating not only urban but also agricultural loadings at the mouth of the Jock River and at the mouth of Mosquito Creek respectively so as not to degrade the Rideau River.

While no investigations in rural areas were carried out in this study, the potential of agriculture operations to degrade water quality is well documented. Improved practices associated with livestock operations would assist in protecting the quality of the watercourses. Therefore,

6. IT IS RECOMMENDED THAT COMPREHENSIVE MANURE MANAGEMENT PLANS IN ACCORDANCE WITH THE AGRICULTURAL CODE OF PRACTICE BE IMPLEMENTED FOR LIVESTOCK OPERATIONS NEAR WATERCOURSES IN THE RIDEAU RIVER WATERSHED TO MINIMIZE THE POSSIBILITY OF POLLUTION FROM MANURE RUNOFF, AND THAT ACCESS OF CATTLE TO OPEN WATERCOURSES NEAR AREAS USED FOR WATER CONTACT RECREATION BE ELIMINATED THROUGH FENCING.

Dry weather problems in the Rideau River below Hog's Back appear to originate from exfiltration from old sanitary sewers and directly connected sanitary sewers. It is not expected that these problems will emerge in the upstream area with more rigorous construction methods and procedures. Cross-connections between sanitary and storm sewers are a result of human oversight and should be dealt with accordingly. Therefore,

7. IT IS RECOMMENDED THAT AREA MUNICIPALITIES INSPECT AND TEST ALL NEW SANITARY AND STORM SEWER CONNECTIONS.

Maintenance of septic systems is left to owners. Malfunctioning units are not readily detectable by instream monitoring programs. Inspections are carried out only after complaints are received. Pollution sources

beyond the study area in the village of Manotick have been documented in TPAC annual reports (1981, 1982). Therefore,

8. IT IS RECOMMENDED THAT SEPTIC TANK SYSTEMS ALONG THE RIVER AND ON LONG ISLAND IN THE VILLAGE OF MANOTICK BE INSPECTED TO ENSURE PROPER OPERATION.

Pigeons at bridges are not a problem in this reach because there are no bridges. A new bridge under construction has been designed without potential roosting areas and therefore,

9. IT IS RECOMMENDED THAT ALL FUTURE RIVER BRIDGES BE DESIGNED IN SUCH A WAY THAT BIRD ROOSTING AREAS ARE MINIMIZED.

Dog litter control by-laws exist in the municipalities draining to the Rideau and if adhered to can improve the water quality of storm runoff and the Rideau River. Street sweeping programs presently followed by municipalities can be modified to increase the effectiveness of control of bacterial contamination. While the analysis in this study shows that these measures are not sufficient by themselves to control existing pollution in the Rideau River, it is clear that benefits would derive for both water quality and aesthetics if modified programs were followed. Accordingly,

10. IT IS RECOMMENDED THAT MUNICIPALITIES CONSIDER MODIFICATIONS TO STREET SWEEPING PROGRAMS AND THAT THAT ADDITIONAL ENFORCEMENT AND/OR PUBLIC EDUCATION PROGRAMS BE INITIATED FOR DOG LITTER CONTROL.

1.3 IMPLEMENTATION AND INSTITUTIONAL ARRANGEMENTS

Although the primary thrust of the Rideau River Stormwater Management Study was towards the resolution of outstanding technical issues respecting the maintenance and control of water quality of the Rideau River below Manotick, it was recognized that an examination of the institutional and implementation aspects relating to the management of water quality should be made. The purpose of the analysis (Report 24) was to review in general terms the legislative and administrative situation respecting the governmental agencies that may affect and be affected by the recommendations of the Rideau River Stormwater Management Study. This review, of necessity relatively general and brief, provided an overview of factors which might impact on technical solutions.

JURISDICTION AND LEGISLATION

A number of agencies in the area have jurisdiction over certain aspects related to quality in the Rideau River. Among these are the Province of Ontario, the Regional Municipality of Ottawa-Carleton (RMOC) and the constituent municipalities, the National Capital Commission, the federal government, the Canada-Ontario Rideau, Trent-Severn (CORTS) and the Rideau Valley Conservation Authority. The reach of river studied lies entirely within the Regional Municipality of Ottawa-Carleton.

The Regional Municipality is empowered to plan, implement and control works "for the maintenance and management of its sewer system, sewage works, treatment works and watercourses". Existing legislation will permit the RMOC:

- To construct and operate any control measures required to improve the quality in the Rideau River to standards deemed appropriate.
- To pass bylaws regulating the manner, extent and nature of the reception and disposal of sewerage and land drainage from the area municipalities.

- To insert into its official plan, policies respecting drainage in the Rideau River watershed.
- To act as a coordinator in respect of land use proposals and their potential impact on the river.

Existing legislation also requires that the official plans of area municipalities shall conform to the official plan of the RMOC and existing legislation states that no public work will be undertaken or by-law passed that does not conform to an official plan.

The CORTS agreement is significant mainly because it resulted in the "Agreement for Recreation and Conservation" (1975, which called for: the acceptance of objectives, an agreement to co-ordinate activities, the establishement of the necessary administrative organizations and the preparation of a policy document to be followed by the participating governments. The policies were released in 1982 (CORTS, 1982).

Key ministries of the Province of Ontario in respect of the RRSMS are the Ministry of Natural Resources and the Ministry of the Environment, although a multitude of legislation and policies of the government of Ontario are applicable to the RRSMS results. Regardless of their specific jurisdictions or interests in the water quality of the Rideau River, it would be advisable and in some cases necessary, to obtain the cooperation and agreement of all the above bodies prior to embarking on any plan designed to control or enhance water quality in the Rideau River system.

POLICIES AND DEVELOPMENT APPROVAL

Existing plans and policies of the municipalities and the Region address the problem of stormwater management in general, and control of water quality in the Rideau River in particular, in varying degrees. Municipalities have addressed planning issues in a number of ways and criteria for the control of new development vary considerably. The

official plan of the RMOC and the official plans of the area municipalities do not include strong and specific policies respecting stormwater quality and management.

The Planning Department of the RMOC currently acts as coordinator and approval agency respecting development by subdivision. It does have the ability, in area municipalities where developments largely proceed by subdivision, i.e. Nepean and Gloucester, to ensure that stormwater works are constructed in such a way that the quality of water in the Rideau River is not degraded. In the cities of Ottawa and Vanier where most development is not by plan or subdivision but by development control, the RMOC is not consulted unless Regional works are affected by a proposal. Therefore;

11. IT IS RECOMMENDED THAT:

a) THE REGIONAL MUNICIPALITY BY AMENDMENT TO ITS OFFICIAL PLAN, ADOPT A STORMWATER MANAGEMENT POLICY AS OUTLINED IN APPENDIX C.

b) AREA MUNICIPALITIES ALSO ADOPT BY AMENDMENT OF THEIR OFFICIAL PLANS, A STORMWATER MANAGEMENT POLICY THAT IS CONSISTENT WITH AND MORE DETAILED THAN THAT IN THE RMOC OFFICIAL PLAN.

c) APPLICATIONS FOR SITE PLAN APPROVAL ARE BROUGHT TO THE ATTENTION OF THE REGION SO THAT THE RMOC CAN ENSURE THAT APPROPRIATE STORMWATER MANAGEMENT MEASURES WILL BE TAKEN IF ANY PARTICULAR CONSTRAINTS ARE KNOWN.

If common policies are adopted by the RMOC and area municipalities in respect of all development, whether by subdivision or development control and appropriate provincial ministries agree with these policies, it would not be necessary for the Ministry of Environment and the Ministry of Natural Resources and other ministries to be consulted on development applications in every case. In accordance with

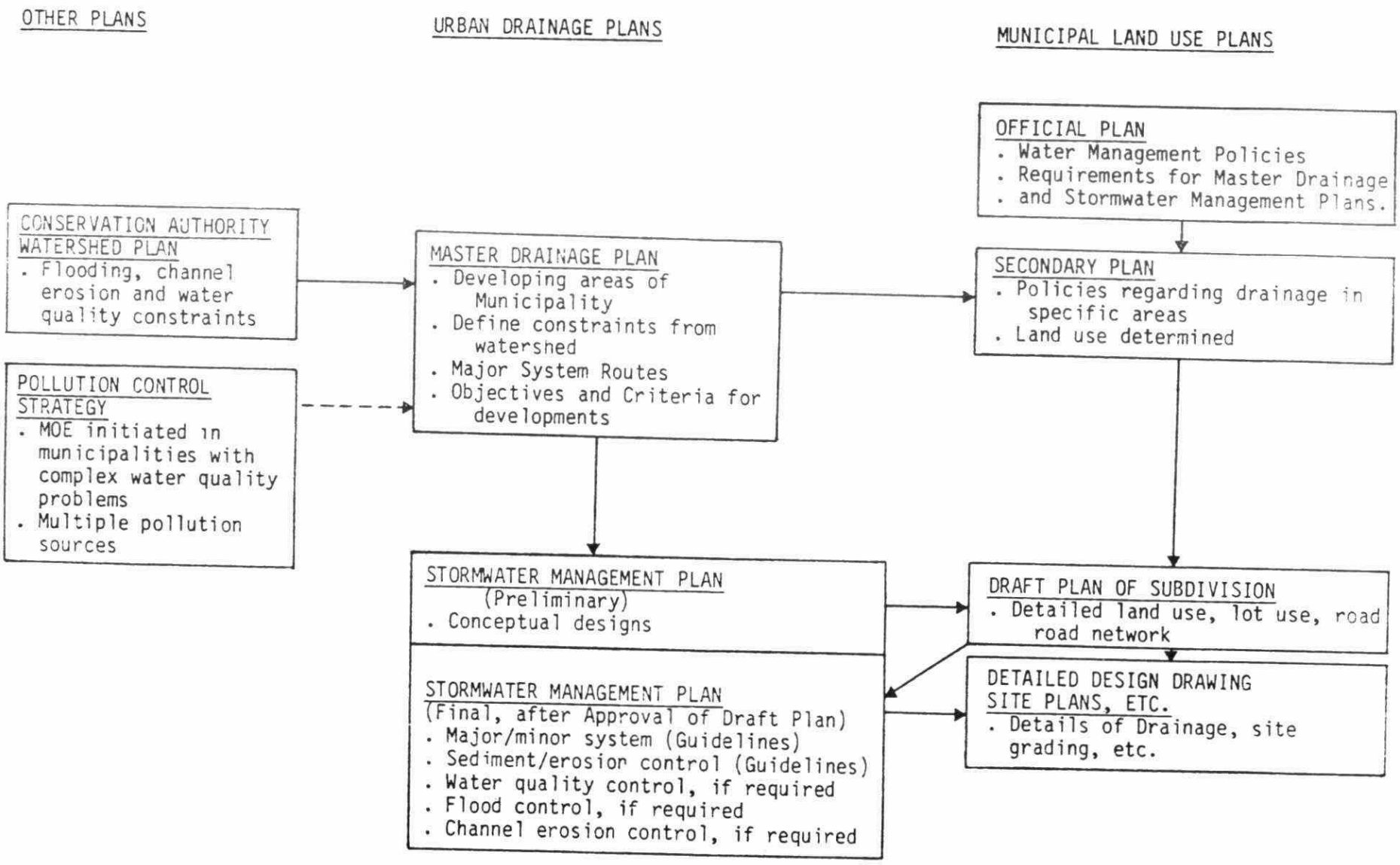
Section 40 of the Planning Act, there is no appeal from the decision of a municipality in the exercise of its development control powers except by the applicant. Thus, the RMOC cannot appeal a decision by a municipal council, neither can a ministry.

As part of the Canada-Ontario Agreement (COA) on Great Lakes water quality, a research program was carried out between 1972 and 1978 to determine the magnitude of pollution from urban drainage sources and to develop analytical and control techniques for these sources. A final report prepared by the Urban Drainage Policy Committee in 1978 (COA, 1980) consolidated all research and development findings and proposed a number of comprehensive policies for urban drainage management. i.e.

- develop master drainage plans;
- formulate and implement a pollution control strategy;
- design storm drainage systems using the major-minor concept;
- address adverse environmental effects in a stormwater management plan; and
- control erosion and sediment production

The report also stated that "the implementation of these proposed policies would provide better coordination between the various government agencies involved and simplify urban drainage administrative and approval procedures". The proposed urban drainage and land use planning process is schematically shown on the next page. Implementation can best be achieved through requirements established in Official Plans, and review and approval of plans following existing procedures contained in the Planning Act.

The province of Ontario established in 1980 an Urban Drainage Policy Implementation Committee with representation from the Ministry of the Environment, Municipal Affairs and Housing, Natural Resources, and Transportation and Communications, together with representatives from the Municipal Engineers Association and the Associations of Conservation Authorities of Ontario. A policy document is being prepared as well as technical guidelines for:


OTHER PLANS
URBAN DRAINAGE PLANS
MUNICIPAL LAND USE PLANS
CONSERVATION AUTHORITY WATERSHED PLAN
. Flooding, channel erosion and water quality constraints
POLLUTION CONTROL STRATEGY
. MOE initiated in municipalities with complex water quality problems
. Multiple pollution sources
MASTER DRAINAGE PLAN
. Developing areas of Municipality
. Define constraints from watershed
. Major System Routes
. Objectives and Criteria for developments
OFFICIAL PLAN
. Water Management Policies
. Requirements for Master Drainage
. and Stormwater Management Plans.
SECONDARY PLAN
. Policies regarding drainage in specific areas
. Land use determined
STORMWATER MANAGEMENT PLAN
(Preliminary)
. Conceptual designs
STORMWATER MANAGEMENT PLAN
(Final, after Approval of Draft Plan)
. Major/minor system (Guidelines)
. Sediment/erosion control (Guidelines)
. Water quality control, if required
. Flood control, if required
. Channel erosion control, if required
DRAFT PLAN OF SUBDIVISION
. Detailed land use, lot use, road road network
DETAILED DESIGN DRAWING SITE PLANS, ETC.
. Details of Drainage, site grading, etc.

- urban drainage design using major and minor drainage systems;
- erosion and sediment control from urban construction sites;
- pollution control strategy formulation.

IMPLEMENTATION

It is important that policies adopted by the RMOC and area municipalities ensure the appropriate operation and maintenance of stormwater management facilities after construction and that sufficient funds be set aside for such purposes. Effective coordination in respect of stormwater management and in particular water quality, requires clear policies, coordinated standards and appropriate consultation between constituent governmental agencies. There is a need for a focus (central authority) to provide technical and administrative guidance, and to ensure that further planning and development for control of water quality in the study area proceeds in an effective and appropriate manner. Therefore;

12. IT IS RECOMMENDED THAT THE REGIONAL MUNICIPALITY:

a) EXPAND ITS EXPERTISE IN STORMWATER MANAGEMENT AND SURFACE WATER QUALITY WITH THE AIM:

- OF ADAPTING TECHNICAL GUIDELINES COMPATIBLE WITH REGIONAL OBJECTIVES, TAKING INTO ACCOUNT THE CONCERNS OF VARIOUS AGENCIES

- OF REVIEWING AND APPROVING DEVELOPMENT OR RE-DEVELOPMENT PLANS BY THE CONSTITUENT MUNICIPALITIES, AND

- OF IMPROVING POLLUTION CONTROL MEASURES SO THAT WATER QUALITY OBJECTIVES CAN BE ACHIEVED AT MINIMUM COST.

b) COORDINATE ALL DEVELOPMENTS HAVING AN IMPACT ON THE WATER QUALITY OF THE RECEIVING WATERS IN ITS JURISDICTION AND PROVIDE EXPERT ADVICE AND GUIDANCE IN INTER-MUNICIPAL MATTERS.

c) ENTER INTO AGREEMENTS WITH INDIVIDUAL MUNICIPALITIES FOR THE SATISFACTORY MAINTENANCE AND OPERATION OF STORMWATER MANAGEMENT FACILITIES TO MEET ESTABLISHED OBJECTIVES AND CRITERIA.

d) PROVIDE SUFFICIENT RESOURCES AND FACILITIES FOR MONITORING OF RIVER WATER QUALITY AND STORMWATER TREATMENT FACILITIES AND DOCUMENT THIS INFORMATION IN ANNUAL REPORTS.

2. OBJECTIVES AND CONCERNS

2.1 HISTORICAL BACKGROUND

The Rideau River is valued and recognized as a unique resource in the Nation's Capital for boating, swimming and other water oriented recreational activities. In the early 1970s concern was expressed by the Medical Officer of Health about the quality of the water in the River for swimming and, subsequently, Brighton, Brantwood and Strathcona beaches were closed (see Figure 1).

Pollution investigations

Pollution investigation and abatement activities were initiated by the City of Ottawa in 1967. These activities consisted of the sampling and investigating of effluents of storm sewer systems and drainage ditches within the City of Ottawa. Bacteriological analyses were used to determine the level of indicator organism of sanitary origin present in the River. A considerable number of corrective actions were taken. With the formation of the Regional Municipality of Ottawa-Carleton (RMOC) on January 1, 1969, the scope of the investigations were expanded to cover all rivers and creeks within the Region.

While the area municipalities had some success in tracing sources of pollution, it became obvious that more support was required and the Ontario Water Resources Commission (now the Ministry of Environment) recommended that a specialist group be set up within the Region's Pollution Control Division to provide the specialized skills and laboratory support to assist the area municipalities in tracing sources of pollution. The actual corrections needed to eliminate pollution sources were to remain the responsibility of each area municipality. Consequently, Regional Council, on February 10, 1971, authorized the establishment of the Pollution Investigation and Abatement Section and started a crash "search and destroy" program.

A Technical Pollution Abatement Committee (TPAC) was established under the chairmanship of the Director of the Region's Pollution Control

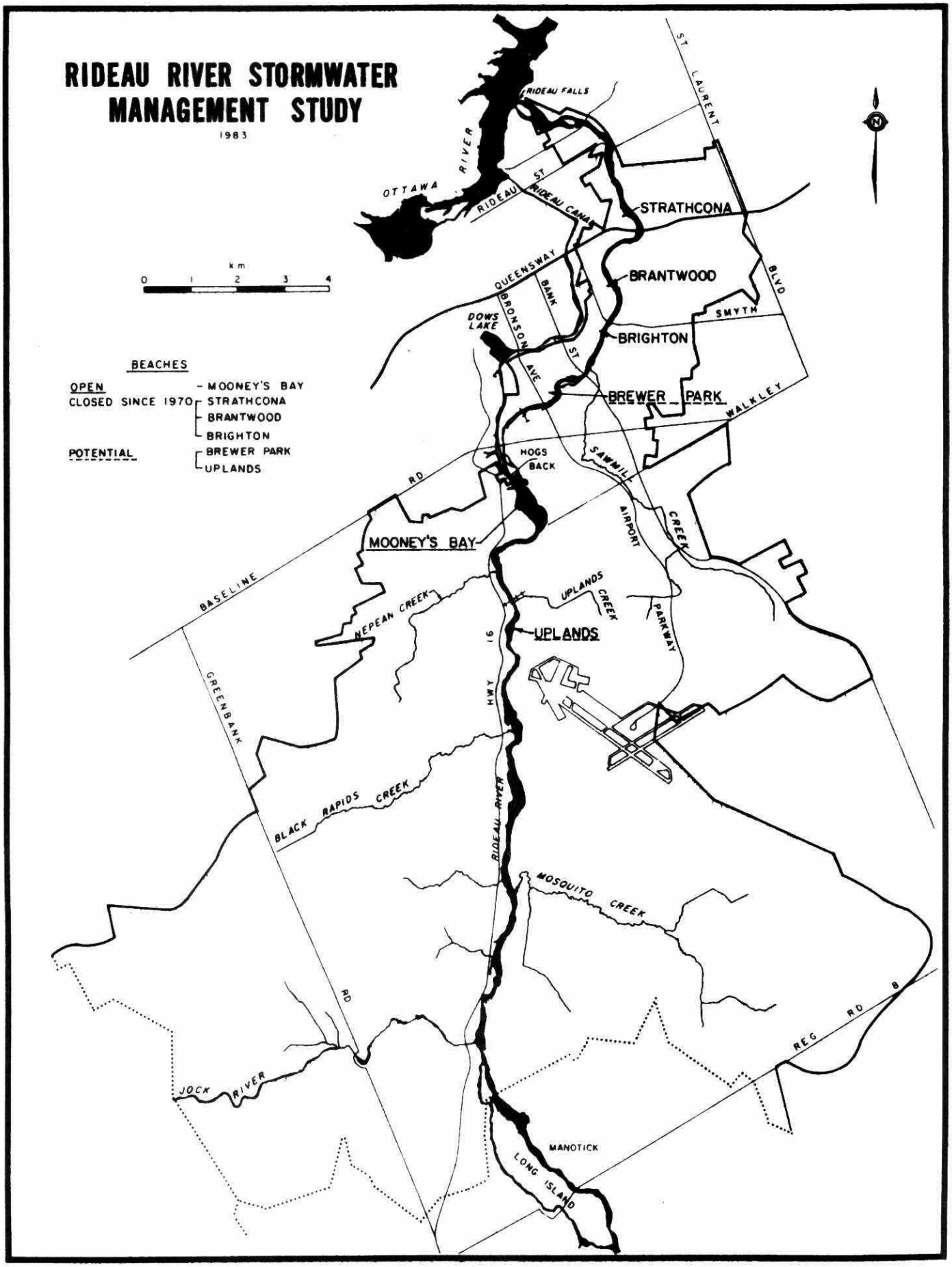


Figure 1: Location of beaches on the Rideau River in the urban area

Division to co-ordinate activities. The Committee consists of representatives from Environment Canada, the Ministry of the Environment, the Regional Health Unit, the Cities of Ottawa, Nepean and Gloucester and the Regional Municipality of Ottawa-Carleton.

Since 1971, many thousands of homes have been dye-tested in search of cross-connections and other sources of pollution; septic tanks have been checked, bacteriological examinations of stormwater systems, creeks and rivers were undertaken as well as visual examinations of potential sources of contamination. As a result of this work, over 700 sources of pollution leading to the Rideau and Ottawa Rivers were discovered and rectified (TPAC, 1978), which resulted in a marked improvement in the quality of the River upstream of Hog's Back. On the other hand, while there was an immediate improvement in the water quality of the river downstream of Hog's Back, this reach has resisted substantial improvement since 1975 and Ministry of Environment objectives and swimming standards were generally not met.

Known pollution sources

At the start of the Rideau River Stormwater Management Study, the following pollution sources were known to exist although they were largely unquantified:

- combined sewer overflows,
- urban stormwater runoff, and
- feces from birds on bridges

Pollution profiles along the lower Rideau established by the RMOC starting in 1978 indicated that birds on bridges were a potential source of pollution. A combined sanitary and stormwater sewer system existing in an older portion of the City of Ottawa discharged intermittently to the River. A program of sewer separation was started in 1971 and accelerated in 1975. The sewer separation program has several objectives:

- protection of basements from flooding,
- reduction of flows to the treatment plant, and
- water quality improvement.

The elimination of overflows to the River is a pre-requisite before swimming will be allowed downstream of the outfall. Out of six overflows in operation when the study commenced, only two are active at present upstream of Strathcona beach. The sewer separation program in the Rideau basin is expected to be completed by 1990.

Concerns

Proposals for large urban developments in the South Urban Community in the mid 70's and the intermittent closure of the Mooney's Bay beach led to a concern by the Ministry of the Environment of further degradation as a result of urbanization. Therefore, in 1976 the Ministry had determined that positive steps should be taken to protect water quality and adopted a policy that there should be no further degradation from future urban development in the area. Stormwater treatment facilities (settling ponds) were required for all new subdivisions. It was also recognized that since the lower reach of the River was almost completely built up, remedial measures would have to be taken if the water quality objectives of the Ministry were to be met.

Swimming standard

The determination of the risk of infection by using water for recreational purposes is based on a number of factors which include:

- sanitary surveys,
- epidemiological studies/data, and
- presence/absence of pathogens.

The enumeration of pathogenic organisms is time-consuming and highly specialized; in addition, they are sparse in recreational waters and difficult to quantify. Thus, bacteriological water quality indicators have been used whose densities in water are related to the presence of sewage or fecal matter and therefore to the risk of contracting a disease from the pathogens potentially contained therein. Bacterial guidelines have been developed by the Ontario Ministries of Health and

Environment (see Appendix B) for a variety of bacterial groups which essentially measure the sanitary cleanliness of the water used for swimming. A potential health hazard was defined to exist if the fecal coliform geometric mean density for a series of water samples exceeds 100/100 mL.

Previous to 1971, the bacterial guideline for bathing beaches in Ontario was 2,400 total coliforms and 600 fecal coliforms. In 1971, a new interim guideline was adopted of a total coliform geometric mean of 1000 and a fecal coliform geometric mean of 100, which was officially accepted in 1973 as the bacterial guideline for bathing beaches for Ontario.

The total coliform group of bacteria includes organisms that are common to vegetation and soil and not from sanitary origin. Therefore, this group is unreliable as a water quality indicator and should not be used as a basis for judging the safety of bathing waters (Schieman, 1981).

In Ottawa-Carleton, a fecal coliform geometric density of 100 is used as the bacterial standard. Any excursion of the densities over 100 is considered to pose a potential risk for bathers.

2.2 TERMS OF REFERENCE

Terms of reference for a comprehensive study of the lower Rideau River were prepared in 1978 by the Ministry of the Environment following discussions with local agencies. The study area was chosen as the urban and future urbanizing area within the Regional Municipality of Ottawa-Carleton below Manotick (Figure 2). This area is 182 km^2 with a length of river of 26 km. The entire Rideau River basin is over 4,000 km^2 in area. The natural flow of the river was modified in the 1830s with the construction of locks along the entire river to provide sufficient depth for navigation. Today the river is being used exclusively for pleasure boating. Various storage lakes in the headwaters ensure sufficient water supply for navigation throughout the

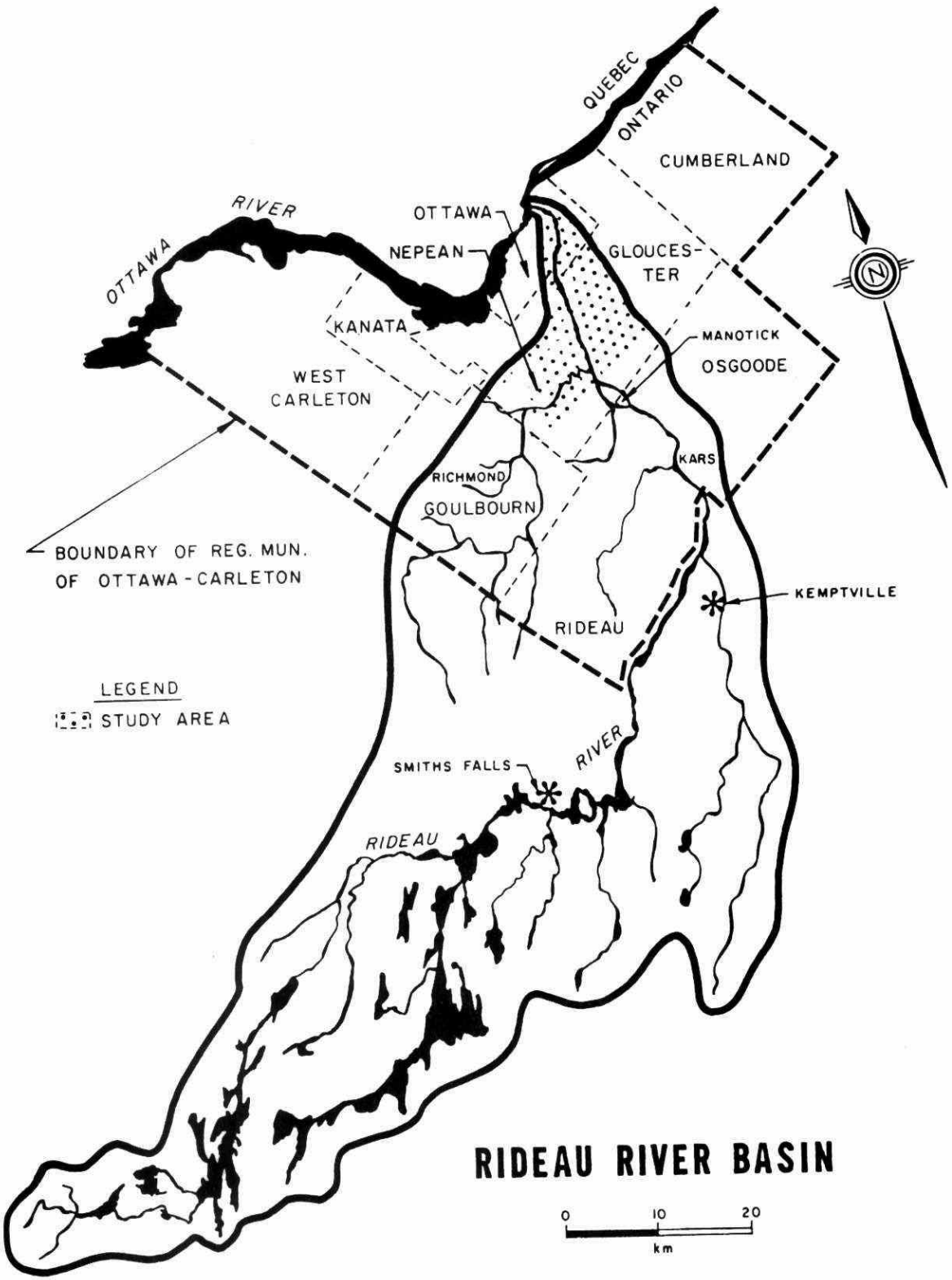


Figure 2: Rideau River Basin and Study Area

summer periods. The study adopted the following objectives.

Objectives

1. To determine the magnitude of pollutant loads to the Rideau River from urban stormwater runoff, combined sewer overflows, agricultural drainage and upstream sources under existing conditions.

2. To determine the effects the loadings and existing hydraulic conditions have on the Rideau River.

3. To predict the pollutant loads expected, and the effect on the Rideau River from future urban developments.

4. To determine the assimilative capacity and allowable pollutant loads to the Rideau River to achieve acceptable water quality for existing and future urbanization, according to Ministry of Environment guidelines and criteria.

5. To determine the effectiveness of existing stormwater management facilities under different operating policies.

6. To assess the effectiveness and cost of various control measures for meeting specific quality requirements at various locations on the Rideau River, including the planned combined sewer control program of the City of Ottawa.

7. To coordinate the study with ongoing studies on specific tributaries and to explore summer flow augmentation by additional storage in the Rideau River system.

8. To provide continued support to interim stormwater management programs.

9. To recommend a comprehensive stormwater management program which will achieve environmental and economic objectives.

10. To identify in consultation with all local recreational authorities:

    (1) the swimming needs of the Regional Community with respect to the Rideau River as may be identified from an investigation of the swimming desires of the people of the Region; and

    (2) the most practical bathing areas, on the basis of identified swimming needs, existing and forecast pollutant loadings and the assimilative capacity of the river for pollution.

2.3 STUDY PLAN

In order to achieve the objectives as outlined in section 2.2, a systematic analysis was proposed consisting of the following major activities:

- Stormwater Runoff

  Identification and quantification of the runoff system, pollution sources and transport system by collection of:
  - land use and drainage system characteristics,
  - runoff quality and quantity data from selected sources,
  - hydrologic data, and
  - calibration and application of models area-wide

- Receiving Water

  Identify the water quality of the Rideau River and develop a receiving water model to study the river's response under a variety of existing and future pollution inputs.

- Pollution Control Measures

  Identify and evaluate a variety of pollution control measures to reduce loadings to the receiving water, e.g. source controls such as

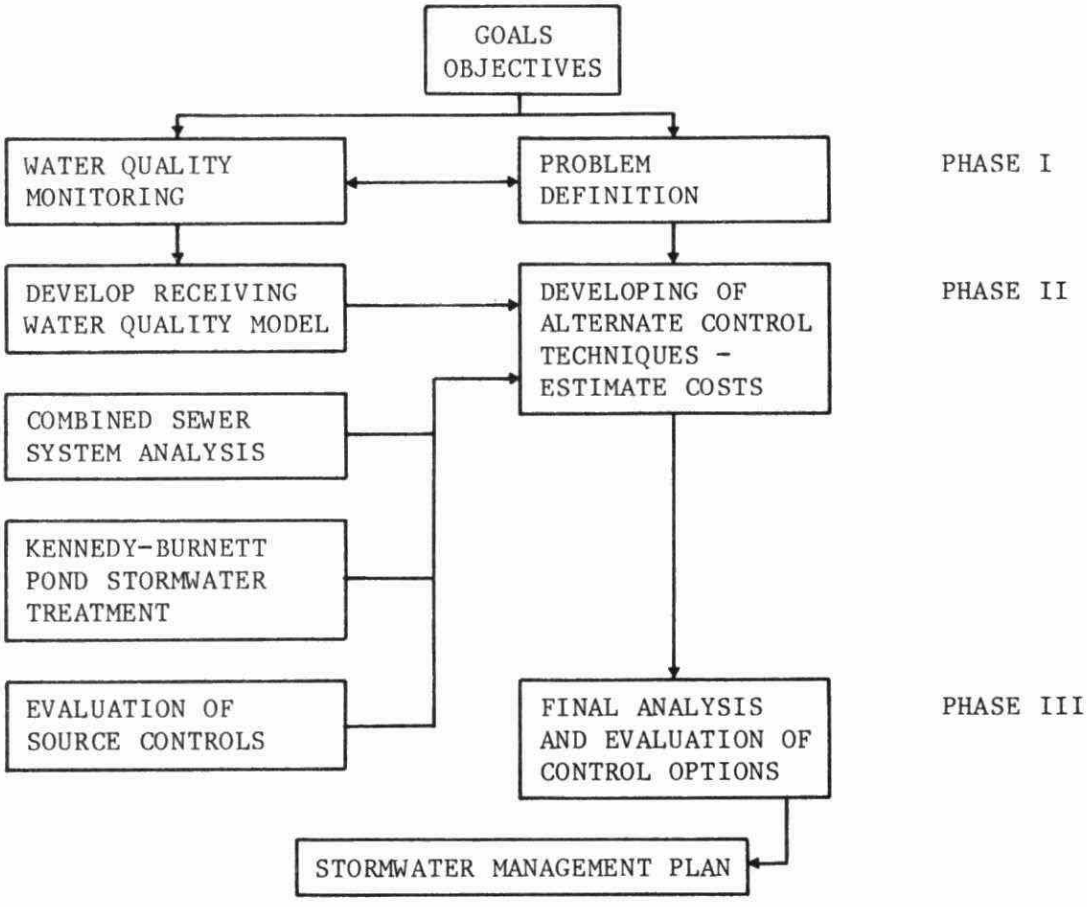
street sweeping and stormwater runoff treatment methods. The Kennedy-Burnett stormwater runoff treatment pond was selected for an in-depth investigation of treatment efficiency under a variety of operating conditions by natural settling, by use of chemicals and by effluent disinfection.

- Optimization

  Determine the most cost effective combination of control measures to achieve objectives.

- Prepare a stormwater management Plan

A schematic outline of the Study is shown below:



As the Study progressed, it became necessary to strengthen the activity of Water Quality Monitoring resulting in a reduction of effort in the activities for the investigation of source runoff controls and Phase II and III. In addition, due to time and resource limitations, phase II and III were combined into one phase II/III.

At the start of Phase II/III (summer 1981) it became apparent that the originally envisaged detailed stormwater management plan (optimum combination of source controls and end-of-pipe treatment) for specific reaches of the river was beyond the Study's resources. The subsequent analysis was therefore limited to the identification of instream constraints resulting from pollution loadings of various sub-catchments and the Study proceeded using mass pollution loadings and frequency distributions of loadings. This resulted in a global definition of pollution control requirements on a sub-catchment basis after development (performance criteria). Detailed analyses to meet these performance criteria could not be carried out.

Sampling of the Kennedy-Burnett catchment and runoff were substantially increased in 1981 in conjunction with the modelling of catchment runoff and pond performance. As a result, only one chemical test was carried out and disinfection of the effluent was not investigated.

3. WATER QUALITY OF THE RIDEAU RIVER

The water quality of the Rideau River is reviewed in this chapter and compared with the Provincial Water Quality Objectives (Ontario Ministry of the Environment, 1978). Of particular interest are the objectives for 'swimming and bathing use of water' which are given in their entirety in Appendix B.

The reach of river of interest has been divided into sectors A to E from the mouth of the Rideau River to the upstream end of the study area in decreasing order of urbanization (Figure 3). Sectors A, B and C are in the developed urban area; sector D is a transition suburban area, and sector E is in the future growth area (South Urban Community). Values for most water quality parameters observed during the Study are summarized by sector in Table 1 together with the objective or guideline. Parameters of special interest or concern are discussed in the text.

3.1 PHYSICAL, CHEMICAL AND AESTHETIC CHARACTERISTICS

An important factor in the perception of water quality as related to recreational uses is the presence of algae, weeds and in-stream vegetation. The impact of in-stream flora on aesthetic and recreational uses has been recognized for some time and documented by Dickman (1974). Phosphorus and nitrogen are the primary nutrients required by plants. In river systems, the ready availability of nitrogen generally results in phosphorus being the limiting nutrient. An assessment of the nutrient ratios in the Rideau River confirm that this condition exists in the reaches under Study (Report 15). Phosphorus concentrations are found to be greater than 30 ug/L in the entire reach from Kars to the mouth of the river (Figure 4), a level sufficient to support nuisance levels of macrophytes and phytoplanktons. Total phosphorus as well as dissolved phosphorus show a marginal decrease through the urban area; total nitrogen loadings from the urban area are insignificant.

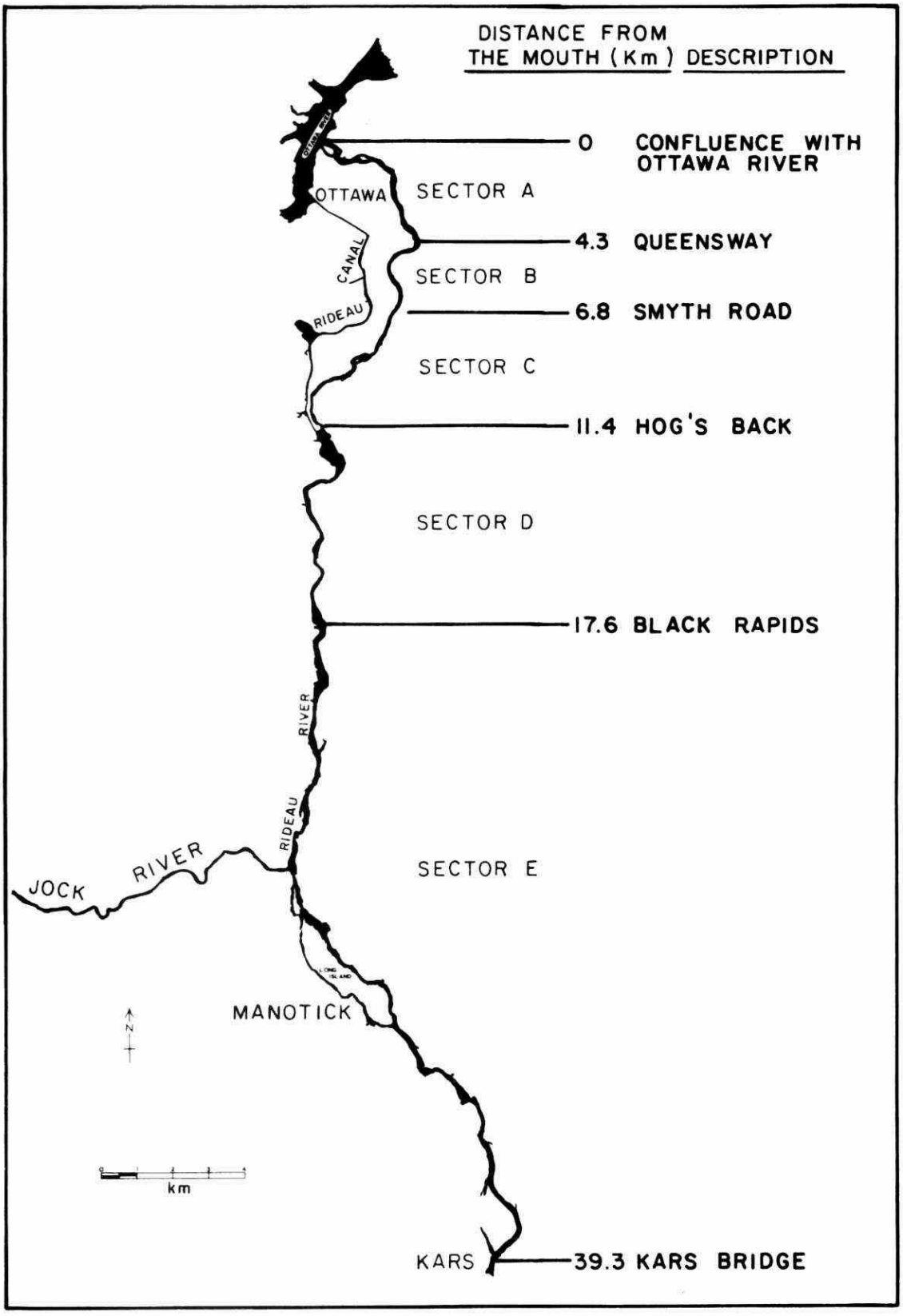


Figure 3: Sector Locations, Rideau River

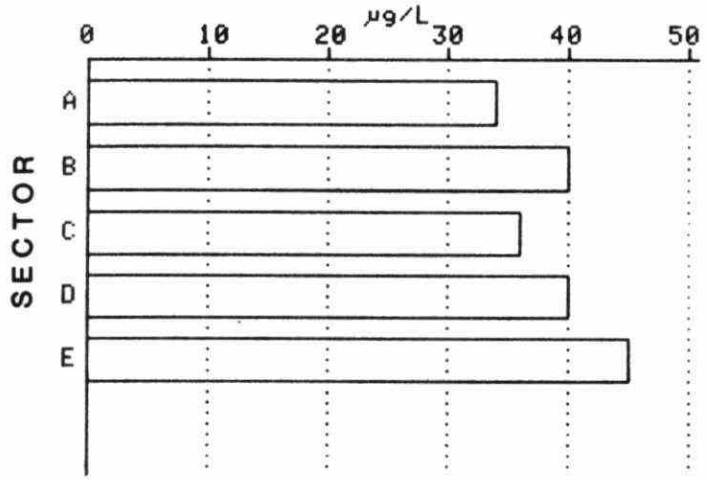


Figure 4: Phosphorus concentration by sector

From an analysis of agricultural and urban loadings to the river, it was concluded that reducing the total phosphorus loading (and dissolved phosphorus) from the urban area will not reduce the concentrations of available phosphorus in the river significantly as in-stream levels already exceeded the Provincial guidelines where the river enters the Study area. Consequently, no further efforts were extended in the Study to reduce nutrient loadings from urban developments.

Management of algae and weeds is most likely to be successful on the basis of site specific controls wherever nuisance levels are attained.

Although the various parameters generally meet the Provincial objectives, a few exceptions should be noted: copper, lead and phenols occasionally exceed the objectives, while ammonia and total phosphorus guidelines are generally exceeded.

Dissolved oxygen depletion attributable to decomposition of algal biomass was noted in bottom waters in the deeper sections of the river. In surface waters, dissolved oxygen was commonly at saturation or super-saturation levels under the influence of photosynthetic oxygen supply.

Table 1: Selected water quality parameters, Rideau River June-August 1978, 1979 (Reports 2, 3 and 15)

Parameter	Units	Mean values by Sector (*) A	B	C	D	E	Objective (**)
Water Temperature	°C	21.7	21.5	21.8	22.4	22.4	
Specific Conductivity	uS/cm	264	257	234	255	218	
Turbidity	NTU	3.4	2.5	2.5	2.5	2.8	
Suspended Solids	mg/L	5	6	5	5	5	
Dissolved Oxygen	mg/L	8.0	7.7	8.2	8.6	8.6	5 at 20°C
Biological Oxygen Demand	mg/L	2.0	1.5	2.0	2.4	3.2	
Total Organic Nitrogen	mg/L	1.67	1.67	1.70	1.75	1.89	
Nitrate (NO_3)	mg/L	.07	.12	.06	.05	.07	
Ammonia (NH_3)	mg/L	.07	.06	.07	.05	.05	0.02
Total Phosphorus	ug/L	34	40	36	40	45	20
Lead (Pb)	ug/L	LT 10	LT 40	LT 10	LT 10	LT 10	25
Mercury (Hg)	ug/L	.06	.05	LT .05	LT .05	.06	0.2
Copper (Cu)	ug/L	LT 6	LT 5	LT 6	LT 6	LT 6	5
Phenols	ug/L	LT 2	LT 4	LT 3	LT 3	LT 4	1
Total Coliform	#/100 mL	16,900	1,400	950	770	210	1000)for series
Fecal Coliform	#/100 mL	760	305	170	36	34	100)of samples
Fecal Streptococcus	#/100 mL	620	530	370	68	33	
Pseudomonas Aeruginosa	#/100 mL	16	9	8	5	3	

(*) Arithmetic mean except bacteria which are geometric mean

u - micro
LT - less than

SECTOR BOUNDARIES (see also Figure 3):

A : Ottawa River to Queensway
B : Queensway to Smyth Road
C : Smyth Road to Hog's Back
D : Hog's Back to Black Rapids
E : Black Rapids to Kars Bridge

(**)Ontario Ministry of the Environment (1978). Water Management - Goals, Policies, Objectives and Implementation procedures

3.2 BACTERIOLOGICAL CHARACTERISTICS

Fecal coliforms

Provincial objectives are generally met in the upper end of the Study area between Long Island and Mooney's Bay (sectors D and E). During periods of heavy rains, elevated densities of fecal coliforms have been observed at Mooney's Bay and elsewhere, but densities generally recover quickly to acceptable levels.

As Mooney's Bay beach is the only open beach in the urban area, frequent fecal coliform measurements are made by the Regional Health Unit (6 times/week in 1982, 10 samples each time). The geometric mean fecal coliform density is about 24/100 mL, well below the swimming standard of 100/100 mL, but still implying approximately 7% of daily values violating the swimming standard over the period June-August as shown in Figure 5.

Below Hog's Back, and in particular, below Brewer Park, fecal coliform densities generally exceed the Provincial objectives. These high levels could be associated with urban stormwater runoff and dry weather contributions. River beaches located in this reach of the river (Brighton, Brantwood and Strathcona - Figure 1) have remained closed since 1970. A summary of the fecal coliform density at all the Rideau beaches since 1971 is presented in Figure 6. A substantial variation can be observed during the swimming season, June-August, from year to year as a result of differences in the amount and distribution of rainfall and flow in the Rideau River.

Rain Effects

The most important factors affecting urban runoff in terms of quantity and water quality are the total event rainfall, rainfall intensity and the inter-event time. The inter-event time is particularly important since this effects the recovery of the river system from pollution loads. An analysis of rainfall for the Ottawa area showed, for example, that almost 70% of the time a dry period of greater than one day will last less than three days. Approximately 30% of the time a dry period

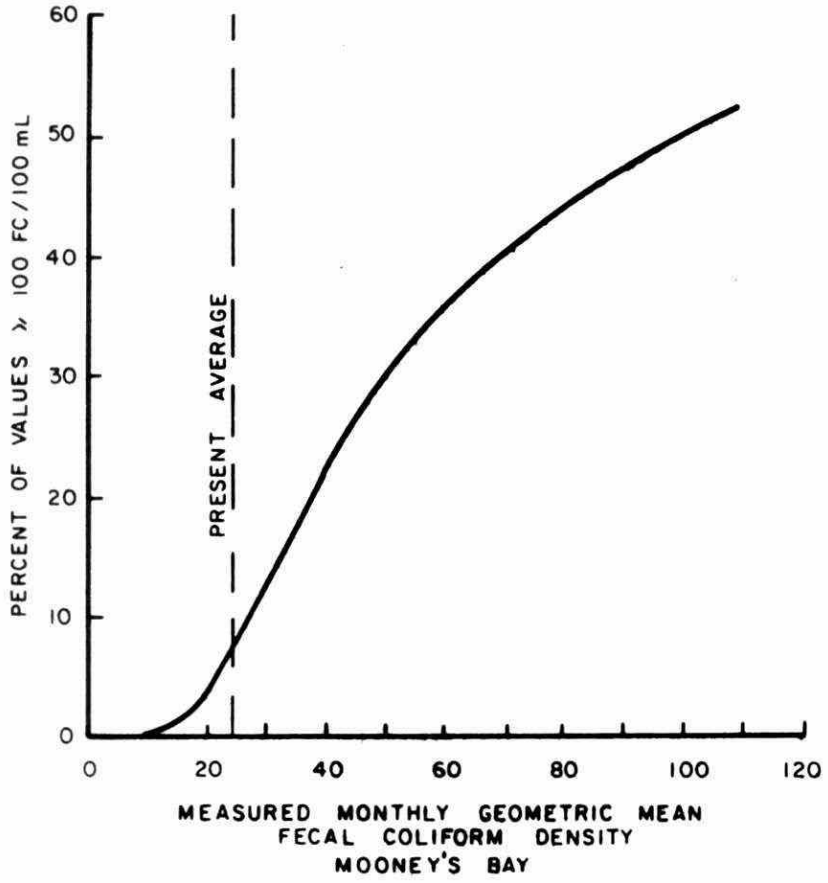


Figure 5: Probability of samples exceeding 100/100 mL for various mean fecal coliform densities at Mooney's Bay, existing conditions

greater than one day will last less than two days. On average, one can expect rainfall in the Ottawa area every three days.

Time of Travel

The time of travel of water in the Rideau River varies depending on the flow rate. During the low flow summer period it may be up to six days between Long Island and Mooney's Bay and from two to three days between

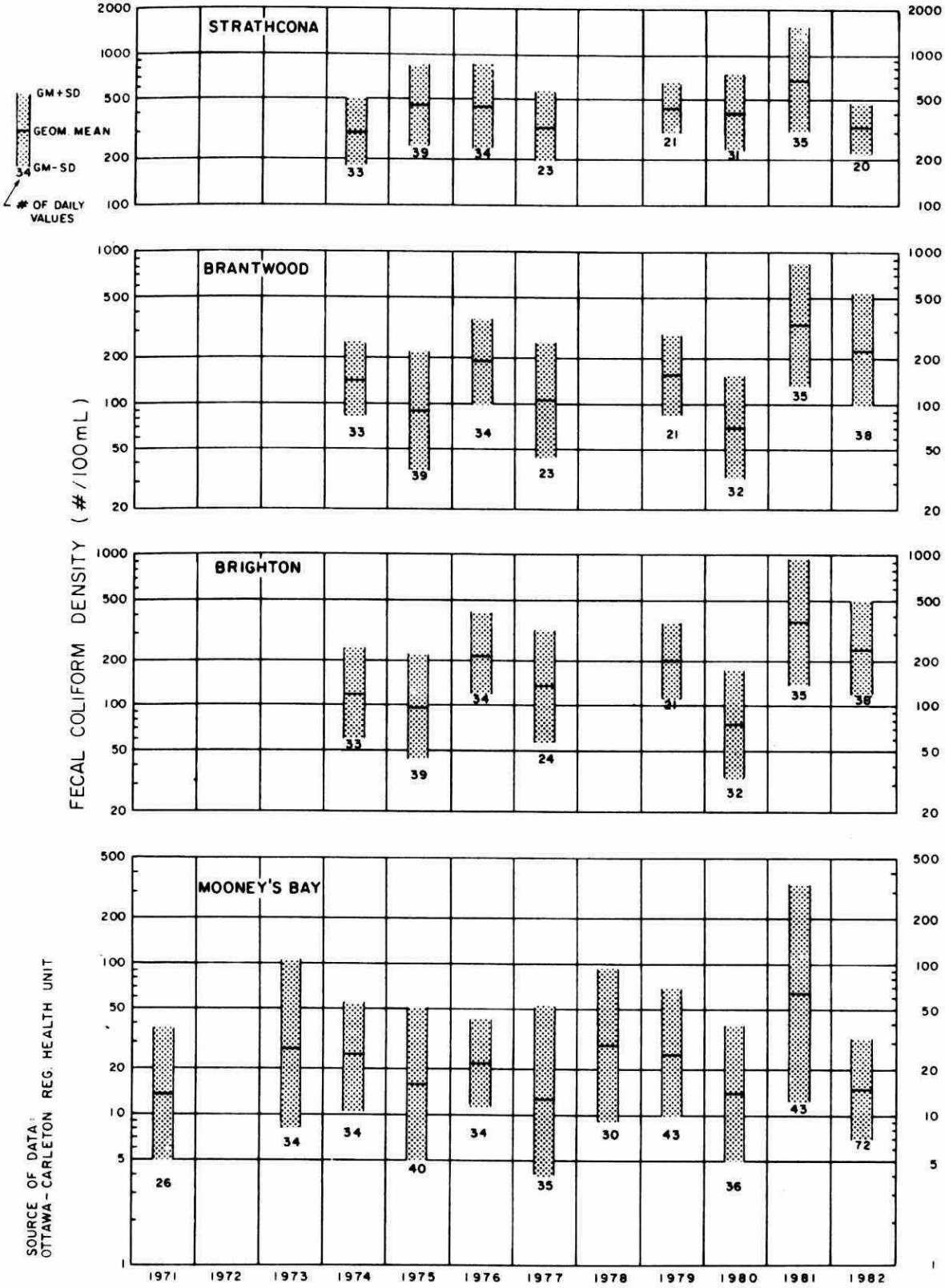


Figure 6: Fecal Coliform densities at urban beach locations on the Rideau River June - August, 1971-1982

Hog's Back and the mouth of the River. Consequently, pollution being washed into the River during average rainfalls (average summer event is about 7 mm) will not be transported downstream quickly, but may linger for up to three days (Figure 7). Dilution, dispersion, bacteria die-off and sedimentation are the major active processes in the receiving water assimilating pollution loadings.

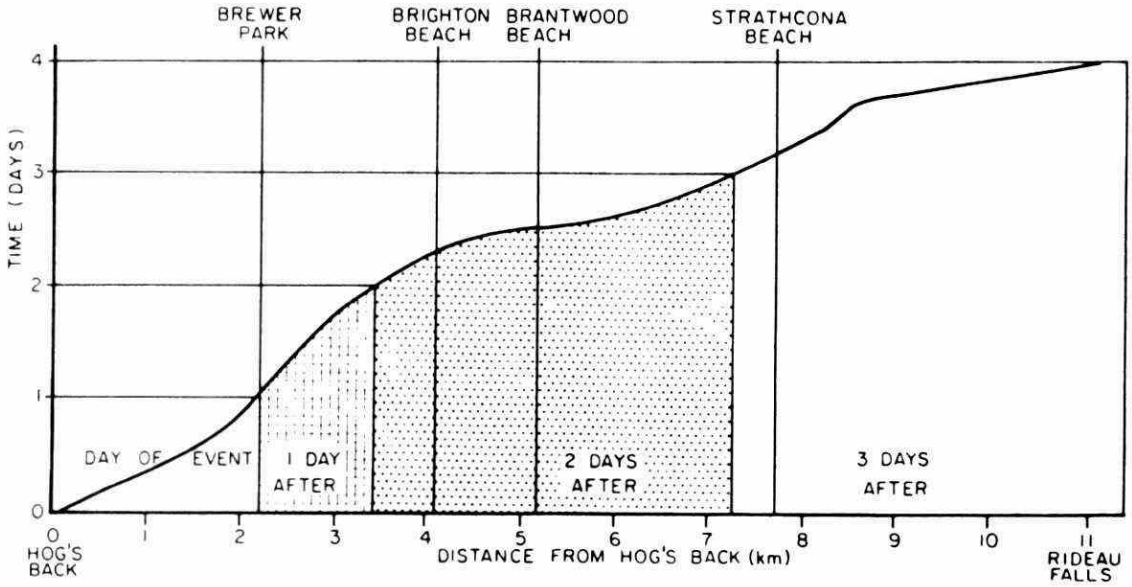


Figure 7: Time to recover to base level fecal coliform density after frequent rain event along the lower Rideau River

Recovery

After major rainfalls, fecal coliform peaks have been observed to travel down the river system. In this regard, the summer of 1981 was very productive in terms of pollution impact monitoring. The month of June had about twice the normal amount of rainfall; July was relatively dry (70% of normal); and the total for August was again more than twice normal, essentially from two major storms. An example of observed and simulated recovery of the river after a rainfall of over 30 mm on June 22, 1981 is given in Figure 8.

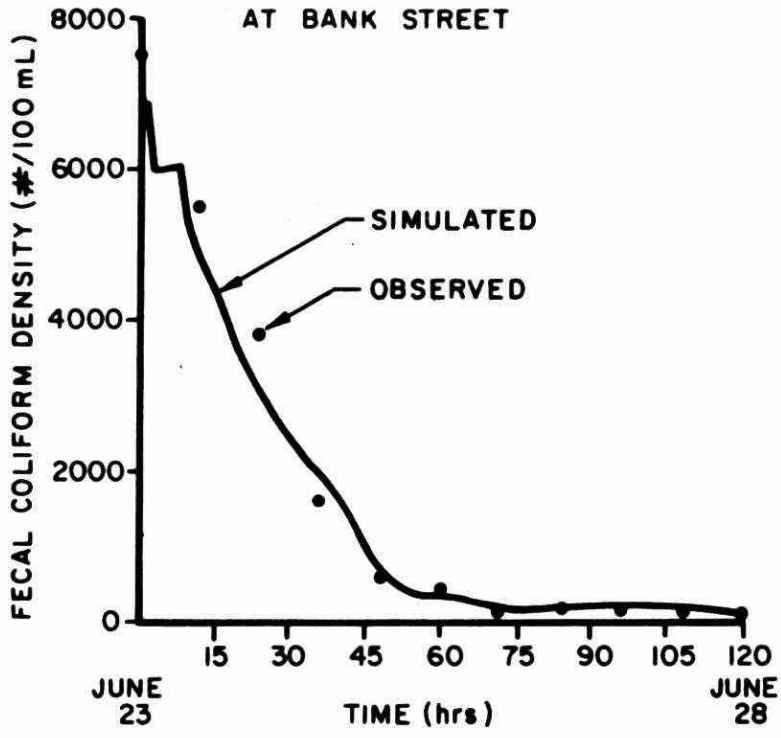


Figure 8: Recovery of instream fecal coliform densities after a major rain storm on June 22, 1981

Dry Weather Profile

After the intensive monitoring program carried out in the summer of 1981, it was possible to quantify with confidence the in-stream processes taking place and interpret the intricate relation between pollution inputs and in-stream densities observed at various times and locations along the river. A composite dry weather fecal coliform profile could be established after sorting of all the data collected in previous years (Figure 9). This profile is consistent from year to year and represents the base level in-stream density two days or more after a rainfall event.

The recovery of the river to dry weather fecal coliform densities (see, for example, Figure 8) is variable along the reach below Hog's Back as shown in Figure 7. The duration of acceptable levels for bathing decreases accordingly. At present, fecal coliform densities below

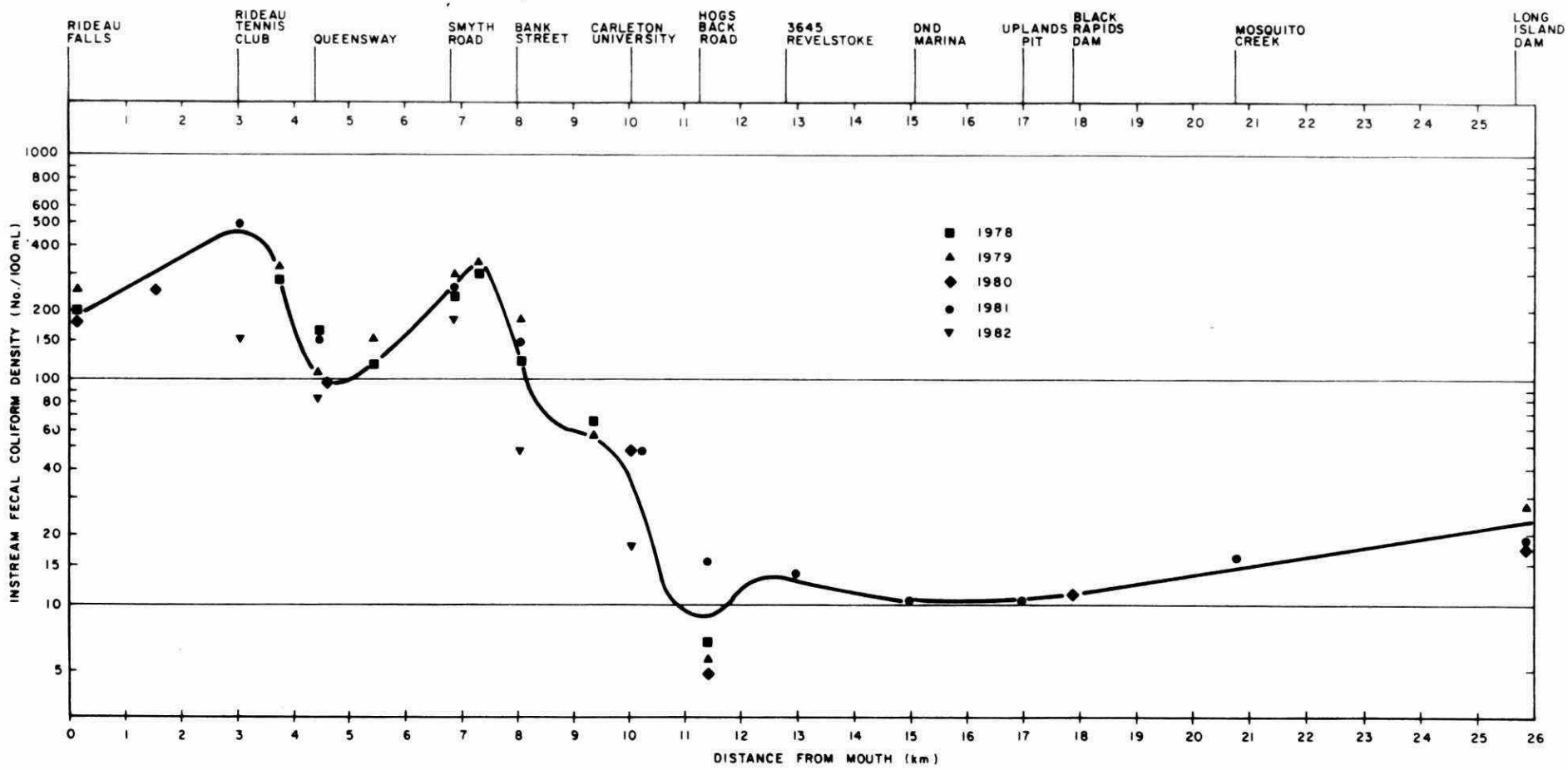


Figure 9: Composite instream dry weather fecal coliform profile at least two days after rain except 1982 - four days or more

Brewer Park are almost always above the objectives even during dry weather, which implies that there are sources of pollution during dry weather. These will be described in the following chapter.

Other Indicators and Pathogens

Routine measurements of other bacteria groups of interest are also shown in Table 1; e.g. total coliforms, fecal streptococcus and Pseudomonas Aeruginosa. Other tests carried out by the Environmental Protection Service (Reports 2 and 3) are summarized below.

Salmonella enumerations were carried out in 1978 and 1979. Out of 63 river samples, two were found positive in 1978; corresponding fecal coliform densities were 960 and 190 #/100 mL. In 1979, 232 samples were tested for Salmonella. Only three samples tested positively; corresponding fecal coliform densities were 260, 590 and 8 #/100 mL. The pathogen density and the sporadic isolation frequency must be considered very unusual. From Geldreich (1970) an isolation success rate of at least 25 to 30 per cent would have been expected (Report 3)

Tests for Candida albicans were also performed in 1978; out of 232 samples, nine tested positive, producing 1 - 2 colony forming units/100 mL. Fecal coliform densities of the positive tested samples ranged from 200 - 5,000 (Report 2).

Water Quality of Tributaries

A good record was available of the bacteriological quality of the tributaries to the Rideau in the Study Area (Table 2). Tributaries in the essentially agricultural/rural areas (Mud Creek, south west of Manotick, the Jock River and Mosquito Creek) do not meet Provincial objectives. The Jock River shows an acceptable fecal coliform density at the mouth near Highway 16, although at upstream sampling locations the objective was also exceeded. The improvement between Greenbank Road and Highway 16 may be attributed to natural die-off enhanced by a number of deep pools and the impoundment upstream of the weir near the mouth.

A general increase in Fecal Coliforms and Fecal Streptococcus may be seen in the densities of the other creeks as urbanization increases. Sawmill Creek shows substantially elevated indicator densities, as well as elevated levels of Pseudomonas Aeruginosa, a pathogenic organism.

Table 2: Bacteriological Water Quality of Tributaries to the Rideau River in 1980

Tributary Water Course	Geometric Mean Density (*) Fecal Coliform #/100 mL	Fecal Streptococcus #/100 mL	Pseudomonas Aeruginosa #/100 mL
Sawmill Creek	895	717	544
Nepean Creek	360	301	51
Uplands Creek	302	418	26
Black Rapids Creek			
at Highway 16	200	237	15
at Merivale Road	167	362	7
Mosquito Creek	175	176	4
Jock River			
at Highway 16	50	97	6
at Greenbank	204	102	7
at Moodie Drive	174	72	5
Mud Creek	159	144	5

(*) based on 33 samples from twice-weekly sampling between May 14 and August 28, 1980
Source of data: Report 4

4. SOURCES OF BACTERIOLOGICAL POLLUTION

4.1 CLASSIFICATION OF POLLUTION SOURCES

Sources of pollution are generally classified as being point sources or non-point (diffuse) sources of pollution. Point sources are usually associated with point effluents from sanitary or industrial waste water plants discharging to the receiving water during dry and wet weather. Non-point sources are then all the other sources of pollution, usually intermittent, which enter the receiving water at many locations and, consequently, are more difficult to locate, control or treat. Agricultural runoff and urban stormwater runoff are considered non-point sources.

4.1.1 POINT SOURCES OF SANITARY WASTE WATER

The Carleton Lodge Sewage Treatment Plant which discharges to the Rideau River at the confluence with the Jock River, is owned and operated by the Home for the Aged. The Works Department of the Regional Municipality of Ottawa-Carleton (RMOC) provides laboratory and supervisory services to ensure the plant is operated at optimum efficiency. This small plant for about 220 people is the only sanitary treatment facility discharging its effluent into the Rideau River in the Study area. The treatment consists of extended aeration with terminal disinfection by chlorination.

The Town of Richmond is being served by sewage lagoons which discharge into the Jock River upstream of Moodie Drive. Under normal conditions, the lagoons are emptied during high flows in the spring and fall periods. This system is operated by the Ministry of the Environment, but works are presently underway to connect Richmond to the western leg of the RMOC trunk sewer system using a forcemain. The Works Department of the RMOC is responsible for sanitary sewage treatment facilities in the Region and has assumed responsibility for all major trunk sanitary sewers. Sanitary waste from the Regional sewer area is treated in two facilities discharging to the Ottawa River.

In the outlying areas, and along the Rideau River upstream of Uplands Creek, residences are still being served by individual septic systems. The Village of Manotick (at the southern limit of the Study area) is served entirely by septic systems. The approval of new septic systems and the inspection of existing ones falls under the jurisdiction of the Ottawa District Office of the Ontario Ministry of the Environment.

The City of Ottawa has responsibility for a sanitary interceptor sewer running along the west bank of the Rideau River from Windsor Park. This interceptor was designed as a collector for the combined sewers in the area bounded by Bronson Avenue on the west, the Queensway on the north and the Rideau Canal on the northwest. The interceptor was designed with overflow structures directly to the River to relieve the sewer during periods of rainfall. Since 1971 the City of Ottawa has been separating the sewer system in this older area resulting in the closure of four overflows during the Study period.

The remaining two overflows to the River below Brantwood Park drain an area of approximately 100 ha. It was estimated (Report 23) that the pollution load to the river represents, on average, less than 2% of the total fecal coliform loading from stormwater runoff. This load is small compared with the overall stormwater loading, but significant in that diluted, untreated human waste is discharged, making the River unacceptable for bathing below these outfalls.

4.1.2 DIFFUSE SOURCES OF POLLUTION

Agricultural runoff and urban stormwater runoff are considered non-point sources. Excess rainfall is carried in a variety of ways from its source to the nearest open watercourse.

In agricultural and rural areas open ditches typically convey stormwater runoff resulting in an appreciable attenuation of the flow peak. Runoff volumes from agricultural areas are also less than from urban areas as a larger proportion of the rainfall is retained by the

irregular surface and increased opportunities are available for infiltration to groundwater.

Urban areas contain a considerable amount of smooth impervious surface and storm sewers convey excess rainfall from the frequent storm events normally taking the shortest route to the nearest watercourse. Thus, there is an increase in the volumes of runoff and peak flows, but also the number of times that pollutants are discharged to the receiving water. Sixty-five (65) storm sewer outlets discharge directly to the Rideau River in the area below Hog's Back, averaging about one outlet per 25 ha.

4.2 POLLUTION FROM URBAN RUNOFF

4.2.1 CATCHMENTS

A substantial amount of effort was devoted in the Study towards measuring the fecal coliform densities in urban runoff. Six catchments were selected ranging in size from 36 to 179 ha and representing various typical land uses (Table 3). The fecal coliform densities summarized in this Table are storm-averaged values; individual measurements varied substantially. The differences between the residential areas is of interest since housing densities are all fairly similar. Mean event values of fecal coliforms appear to increase with the age of development leading to the conclusion that older areas generate higher fecal coliform densities. A major shopping centre (Coventry-St. Laurent) showed the lowest values of the catchments investigated (Report 30).

Fecal coliform densities of combined sewer overflows at Clegg Street are about a factor 100 higher than urban stormwater runoff. Sanitary sewage densities are given for comparison only. They may be considered as typical for weak domestic sewage resulting from dilution by infiltration.

The fecal coliform densities observed in the runoff from selected urban catchments are naturally related to land use and the intensity of activity performed thereon. The data was used for calibration of a mathematical model (STORM) and whereafter the model was used to calculate bacteria loadings to the Rideau River over the entire Study area for typical rainfall series (Report 19).

Table 3: Fecal Coliform Bacteria Densities in Catchment Runoff

Catchment/Land Use	Area (ha)	Number of Storms	Fecal Coliform Densities (#/100 mL) Mean(*)	Min	Max
Leonard Recently separated residential area	37	5	21,700	11,500	64,100
Alta Vista Older residential area incl. 56 ha of undeveloped land	179	11	14,100	5,900	38,000
Chesterton Newer residential area	72	7	12,300	720	96,600
Kennedy-Burnett Developing sub-urban area	60	32(-)	6,900	220	64,500
Coventry Commercial-shopping centre	36	11	4,580	540	31,400
Clegg Overflow from combined sewer in residential area	78	7	1,900,000	500,000	9,000,000
Clegg - Sanitary Sewer, Dry Weather Flow August 17-19. 1981			3,400,000	1,700,000	12,000,000

(*) geometric mean of flow-weighted averaged densities for storms
(-) storm events, defined as time interval over which the flow exceeds the dry weather rate.

4.2.2 URBAN BACTERIA SOURCES

A separate study was conducted to define urban bacteria sources in runoff and their control by street cleaning in the lower Rideau River watershed (Report 21). A field project was conducted in August and September 1981 involving the collection of various dry and wet weather urban source samples (street dirt, parking lot runoff, rooftop runoff, vacant land runoff, sewerage sediments, etc.). The bacteriological information is summarized in Table 4. Other studies in North America offer relatively little data for bacteria. Reported fecal coliform densities in street dirt in the United States (Report 21) ranged from ten to more than 100,000 organisms/g of total solids with a mean value estimated at 10,000 organisms/g. This is substantially greater than the mean values observed in Ottawa.

Table 4: Typical Bacteria Population Densities in the Ottawa area

	Fecal Coliforms	Fecal Strep.
water samples (organisms/100 mL)		
Urban Runoff	10,000	n.a.
Snowmelt	2	2
Catchbasin Sump	50	300
Gutter Flows	4,000	20,000
Parking Lot Puddles	3,000	10,000
Vacant Land and Park Puddles	6,000	20,000
Rooftop Runoff	100	200
Disturbed river sediment/water	2,000	n.a.
sediment samples (organisms/g solids)		
Sediments in Storm Sewer	8,000	20,000
Catchbasin Sump	20	100
Street Dirt		
smooth and moderate texture	400	2,000
rough texture	100	1,000
very rough texture	10	3,000

Streets

A complete survey of street lengths, textures and conditions was conducted for the entire study area (Report 31) and a special analysis of long-term Ottawa rain conditions (Report 17). From the data gathered, daily street particulate loading values were estimated for periods from 0 to 7 days. The accumulation rates were then combined with the rainfall history and a washoff model to generate urban runoff yields of bacteria for all catchments.

A comparison with the measured pollution loads from selected catchments showed that there were from 2 to 7 times the fecal coliforms on the streets before the storm than were observed in the runoff. Urban runoff bacteria yields are therefore not source-limited, but are more controlled by the ability of the rain to dislodge and transport the bacteria from the source areas to the outfall.

A runoff producing rainfall will therefore not completely clean the street surface of indicator bacteria and a substantial fraction of the total loading will remain on the streets even after large rain events. In addition, during large rain events bacteria may be washed from the surrounding pervious areas onto the streets for subsequent removal.

Source areas

When a drainage area has much of its surface paved, the urban runoff bacteria concentrations can be expected to peak near the beginning of the rainfall event and then decrease as the event continues. Initial high levels of bacteria may be associated with direct flushing of feces from paved surfaces. These feces are from domestic animals defecating in parking lots and street areas and from birds roosting on rooftops.

When a drainage area has a lot of landscaped areas or open land, relatively high bacteria concentrations in the urban runoff may occur throughout the rain event as material is being washed off from the pervious areas. Small rains (less than 10 mm) have most of their runoff pollutants originating from directly connected impervious areas.

Pervious areas do not contribute substantial quantities of pollution until the total rain volume exceeds 10 mm.

The ratio of fecal coliform to fecal streptococcus bacteria densities may be indicative of the probable fecal source. (Geldreich, et al, 1968). Observed fecal coliforms to fecal strep. population ratios in the Study area (Table 5) confirm that the surface sources are animals.

Table 5: Fecal coliform to fecal strep. bacteria population ratios in study area

	FC/FS (ratio)
Source Areas	
Rooftop runoff	0.5
vacant land puddles	0.3
parking lot puddles	0.2
gutter flows	0.2
average.....	0.3
Catchment Runoff	
Kennedy-Burnett	0.4

Birds and pets

The amount of surface deposits of animal feces is largely dependent on the pet population and thus directly related to the density of residential urban development. An estimate was made of the bird and pet populations in the Study area and this information, combined with the feces discharge for each animal per day and the bacteria density, provided an indication of the relative magnitude of the various sources contributing to elevated bacteria densities observed in-stream. It was calculated that dogs contribute a significant load of fecal coliforms which will be washed into the River by stormwater; birds living near the River environment were also found to be a significant source of direct input at bridges.

4.2.3 SEWER TRANSPORT SYSTEM

Another important link in the drainage system is the storm sewer network. Sediments can be temporary sources or sinks of bacteria. In addition, animals inhabiting the sewers themselves add to the fecal coliform load. Most importantly, however, is the possibility of contamination of storm sewers from sanitary sewers by cross-connection of sewers, i.e. sanitary sewer leads connected to the storm sewer.

Many cross-connections have been corrected in the past as a direct result of the efforts of the Technical Pollution Abatement Committee (TPAC) but new ones are still found every year. It is worth noting here that although City by-laws require an inspection of new plumbing systems (dye testing) before a building can be occupied, cross-connections in new buildings are regularly found. Alterations made to the plumbing system without a permit can only be detected by monitoring. Therefore, a continuous and rigorous program of monitoring and testing should be maintained by the RMOC.

Typical bacteria population densities presented in Table 4 are necessarily generalized. They do, however, show the effect of the sewer transport system in that the densities at the end-of-the-pipe appear to be higher than the inputs (gutter flows/park puddles). A 'clean' storm sewer (no sanitary contamination or animal feces in the sewer) should not exceed the input densities. The Kennedy-Burnett data shown in Table 3 appear to approach the value one would expect in an area where no sanitary cross-connections existed.

4.2.4 DRY WEATHER LOAD

The Qual-II model was used extensively in the Study. The model is ideally suited for testing the effect on the receiving water of pollutant inputs under steady state conditions at various locations as transport, dispersion and bacteria die-off are all incorporated. After calibration of the model (Report 19), it was set up to reproduce the observed in-stream fecal coliform densities during a selected period in

1981 (Figure 10). The calculated input rate profile follows closely (but not surprisingly) the in-stream profile. Of more interest, however, is the perceived background input rate, about 5000 FC/m/s below Carleton University and about 1000 FC/m/s upstream.

No appreciable impact on the river during dry weather can be established for the developed area upstream of Hog's Back except immediately upstream of Mooney's Bay. However, in the older urban area the contribution is noticeably higher and related to the directly tributary sewered area (Report 23). Measurements of accessible storm sewers in this area during dry weather show an average fecal coliform density of 273/100 mL. However, the load (density times flow rate) was much smaller than the inputs shown in Figure 10. Hence, other sources are suspected.

Sanitary sewers in older areas of the City of Ottawa were constructed without gaskets. Thus leakage (exfiltration) from joints or broken pipes may contribute to river pollution. Leakage may go unnoticed if not intercepted by a storm sewer being monitored. Since the sanitary sewer generally lies below the storm sewer seepage to the river through permeable backfill, fissures or groundwater may exist.

The stream analysis was carried a step further by simulating various background input levels (Figure 11). A loading rate of 5000 FC/m/s appears to provide an acceptable range of dry weather in-stream densities below Hog's Back. To achieve this level, sources between Carleton University and Smyth Road and below the Queensway must be eliminated (Figure 10).

The levels shown in Figure 11 are for dry weather, two days after a rainfall. Wet weather inputs will raise the in-stream levels frequently and control of these inputs is also required to achieve an acceptable frequency of fecal coliform densities below 100/100 mL for bathing.

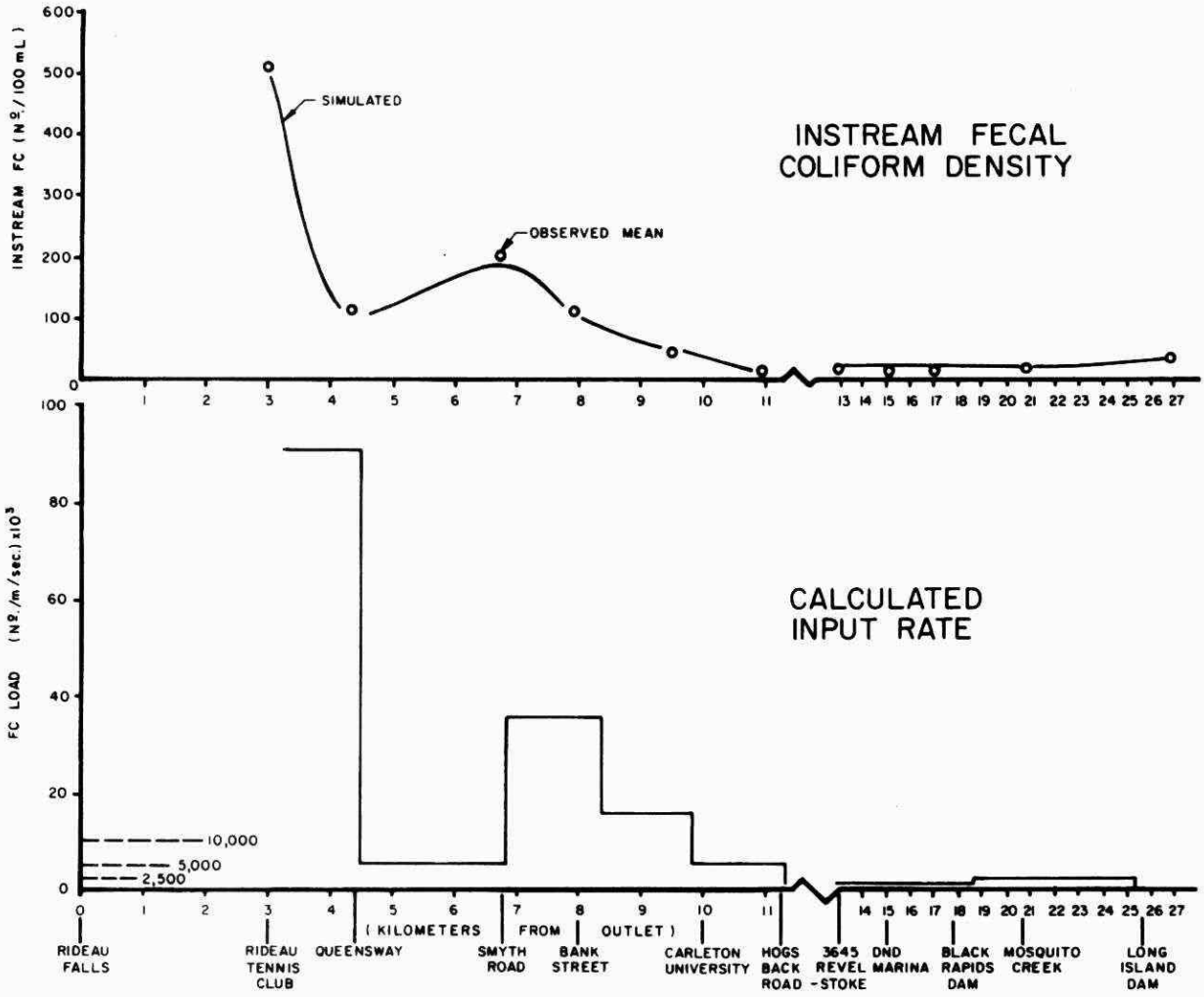


Figure 10: Dry weather model calibration

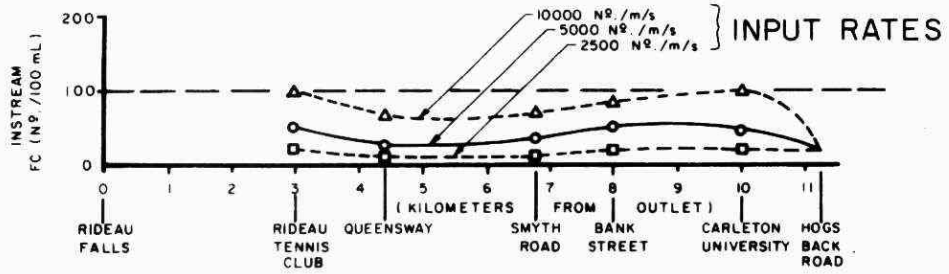


Figure 11: In-stream responses to selected dry weather input rates

4.3 POLLUTION FROM RURAL RUNOFF

Although at the start of the Study, the collection of data on bacteriological pollution from agricultural areas, vis-a-vis urban areas, was considered and a field program was prepared, the monitoring program was unsuccessful. Two recent studies in Ontario have documented bacterial pollution in agricultural areas.

A microbiological study was conducted as part of the International Joint Commission's (IJC) Pollution from Land Use Activities Reference Group (PLUARG) on eleven small agricultural watersheds in Southern Ontario from April 1974 to April 1977 (Ontario Ministry of the Environment, 1981). In most of the watersheds, water quality was extremely poor (not suitable for body contact recreation) and bacterial pollution appeared to be localized and site specific.

In another study in the Avon River near Stratford, it was observed that significant increases occurred in indicator bacteria densities while cattle were in the stream for watering or crossing (Stratford/Avon Environmental Management Project, 1983).

Runoff transports bacteria from manure storage areas, barnyards, feedlots, manure-laden soil, pasture and from wild animals to the stream. In addition, seepage from septic tanks may contribute to elevated densities of indicator bacteria in agricultural areas.

Point sources and agricultural practices are most likely more significant in terms of water quality degradation than areal accumulation. Larger amounts of rainfall are required to wash-off pollutants as compared to a sewered drainage system in urban areas, and whenever this happens the agricultural loadings are expected to be larger than urban loadings. The highest instream fecal coliform densities were observed in the largely agricultural section of the Study area during heavy rains in June 1981 (Report 32).

4.4 SUMMARY OF POLLUTION SOURCES

Major sources of bacterial pollution described in the preceding sections are summarized in Table 6 categorized by system component and by its impact on the water quality of the Rideau River. A clear distinction has been made between sources contributing a load during dry weather or during rainfall events. The later sources need a transport mechanism to be moved into the receiving water.

Table 6: Major bacteria sources affecting the water quality of the Rideau River.

MAJOR IMPACT IN	SYSTEM COMPONENT	POLLUTION SOURCES	
		Below Hog's Back	Above Hog's Back
DRY WEATHER	SANITARY SEWERS	Leakages (*): . Carleton University to Windsor Park . Below Queensway	None
	RIVER ENVIRONMENT	Pigeons on bridges, Ducks & swans on open water	None
WET WEATHER	URBAN RUNOFF	Wash-off of dog feces Wildlife in sewers Cross-connections Combined sewer overflows	None
	RURAL RUNOFF	None	Livestock operations near watercourses

(*) originating from directly connected sanitary sources, exfiltration and sewer cross-connections.

The resulting violations of the swim;ming standard are summarized in Figure 12. The leftmost part on the graph (Mooney's Bay) should be considered as representative of the upper reach conditions (Hog's Back to Long Island). The cause of deterioration appear to be different in the two reaches. Pollution sources in each reach are described below.

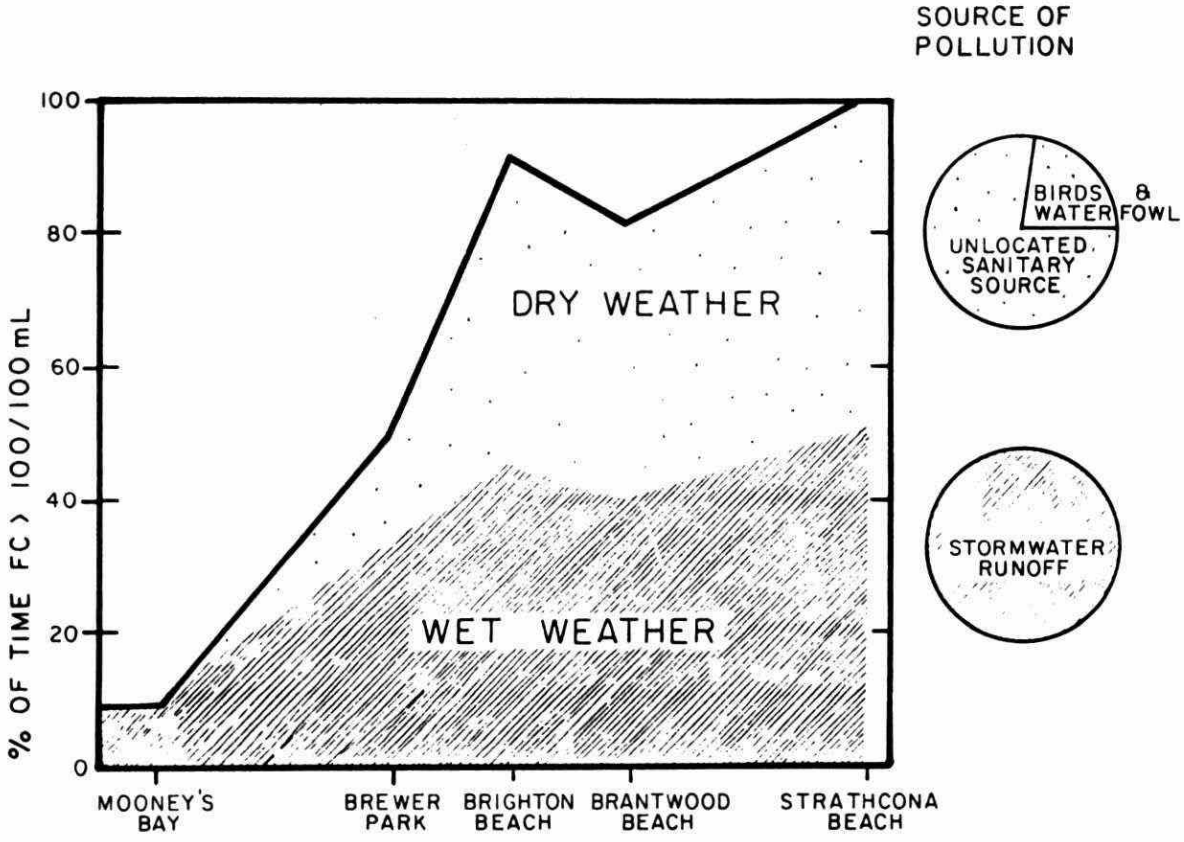


Figure 12: Average duration of exceedance of bacteriological swimming standard by source of pollution over the period June-August

4.4.1 HOG'S BACK TO OTTAWA RIVER

A composite dry weather profile of instream fecal coliform densities was presented in Section 3.2 (Figure 9). Dry weather in this context is defined as a rain-free period of two days or more. The apparent consistency of the observations from year to year below Hog's Back indicates that the sources are equally persistent. Small differences between years are caused, among other things, by variations in the flow rate and the length of the dry period.

Fecal coliform densities are consistently over the objective of 100 fecal coliforms/100 mL below Bank Street with a pronounced decrease between the Smyth Road Bridge and the Queensway. The specific source(s) could not be determined but the sanitary system is suspected since measured densities and flows in the storm sewer systems

investigated could not account for the high in-stream levels. Bacteriological tests carried out in the summer of 1982 support the deduction that the sources are of human origin (Report 12). Birds, although a direct source, could not account for the elevated levels alone.

The estimated total dry weather sources of pollution to the River between Hog's Back and the Rideau Tennis Club are also shown in Figure 12. It was concluded (Report 23) that the estimated contribution from pigeons at the various bridges and ducks and swans (birds and waterfowl) are sufficient to raise the dry weather instream fecal coliform densities to about the maximum considered acceptable by the health authorities for safe bathing. Over 75% of the dry weather sources (unlocated sanitary sources) have not been measured either by the detailed monitoring in 1978 and 1979 by EPS, the Rideau River Stormwater Management Study in 1981, nor the long-term effort by the RMOC.

It has been observed from many years of regular sampling at Strathcona Beach below the Queensway by the Regional Health Unit, that fecal coliform densities typically increase during the summer as flows in the River decrease, thereby pointing to a fairly constant source(s) discharging to the River at or below the Queensway bridges.

After all dry weather pollution sources are eliminated, it is expected that swimming standards would still be exceeded over 40% of the time below Bank Street (Figure 12). This is a result of frequent inputs of polluted stormwater and the time required for the river to recover to base levels after rainfalls (Figure 7).

4.4.2 HOG'S BACK TO LONG ISLAND

Dry weather inputs to the River above Hog's Back (see Figure 10) do not appear to be significant at the present time except just upstream of Mooney's Bay where small increases in instream levels are observed (Figure 9) and near the top end of the study area at Long Island where

some effect from the Village of Manotick is indicated. Leaking septic tanks in Manotick have been reported in the 1981 and 1982 TPAC reports.

Analysis of the impact of stormwater runoff from continued urban development established that areas inside the Greenbelt only appear to have a significant effect on water quality at Mooney's Bay. Development outside the Greenbelt would have a minimal effect at Mooney's Bay, although water quality would deteriorate locally near the point of discharge. Livestock operations near watercourses can also contribute significantly to water quality degradation especially during larger rainfall events.

5. WATER QUALITY GOALS AND RECREATIONAL OPPORTUNITIES

Sources of bacterial pollution were reviewed and quantified in the previous chapter. It was noted that upstream of Hog's Back swimming standards are on average violated 7% of the time during the summer swimming season, while below Hog's Back the percentage of violations increases such that below Bank Street the swimming standards are exceeded on average over 80% of the time.

The goal of water management in the Province of Ontario with respect to surface water quality is: *"to ensure that the surface waters of the Province are of a quality which is satisfactory for aquatic life and recreation"*. The Provincial Water Quality Objectives for swimming and bathing use of water (Appendix B) state that *"a potential health hazard exists if the fecal coliform geometric mean density for a series of water samples exceeds 100 per 100 mL"*. Hence, the objective of water quality management for optimum use of the water for swimming is zero violation of the fecal coliform density of 100/100 mL.

5.1 RIDEAU RIVER ABOVE HOG'S BACK

Dry weather water quality is satisfactory for the entire reach. The Mooney's Bay beach is located in the lower part of the reach and the mean geometric fecal coliform density over the summer period June-August is about 24/100 mL. Individual daily measurements show that on about 7% of the sampling days the bathing standard (100/100 mL) is exceeded. The exceedance of the standard was shown to be associated with area-wide uncontrollable stormwater runoff from the largely undeveloped agricultural area. Further reduction of violations would therefore require control of agricultural runoff. Improvements in agricultural practices could reduce the impact on the receiving water for smaller rainfall events, but would probably result in marginal improvements for the larger events.

The swimming standard violations are assumed to be associated on average with four rainfall events over the summer period in excess of 25 mm.

Their control would be very expensive if at all feasible. Hence, the Ministry of the Environment specified a target of no degradation with further development upstream, or in other terms, no increase in the frequency of in-stream violations of the fecal coliform standard for swimming after development or redevelopment.

5.2 RIDEAU RIVER BELOW HOG'S BACK

This reach of the river does not meet the Provincial Water Quality Objectives. The violations of the swimming standard summarized in Figure 13, show dry and wet weather to be sources of pollution.

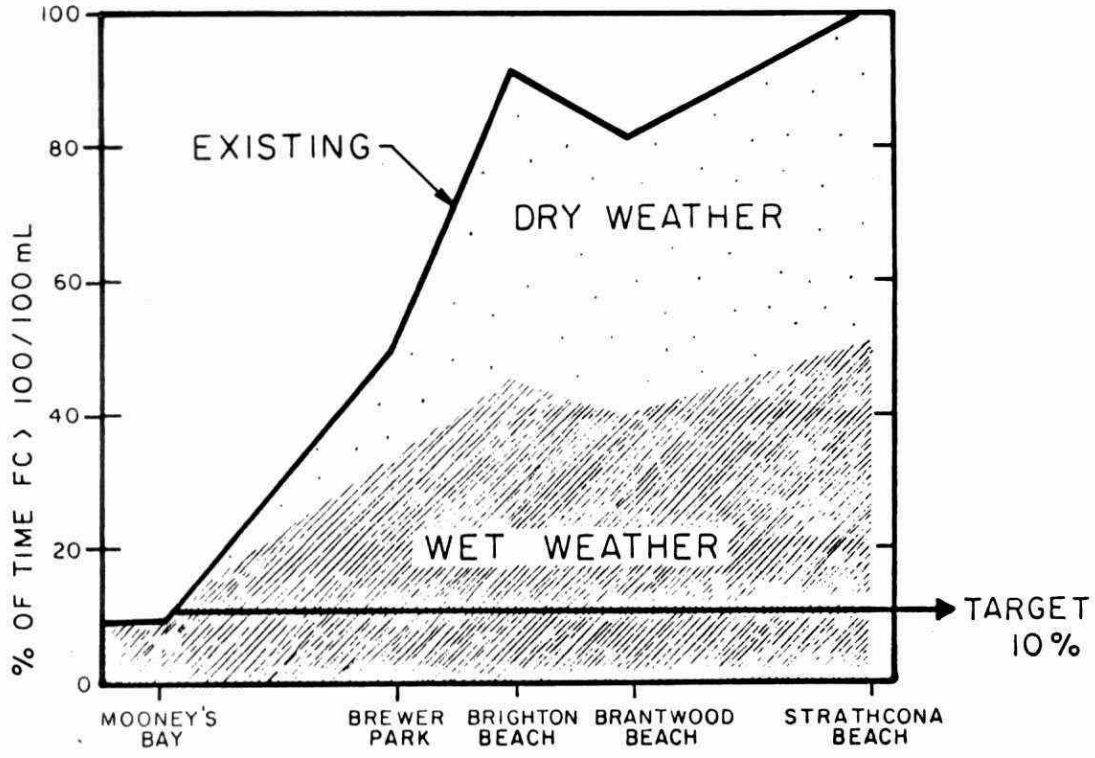


Figure 13: Existing violations of the swimming standards and proposed target level

Figure 13 shows that for example elimination of dry weather pollution sources alone will not be sufficient to meet objectives; wet weather (stormwater) runoff must be controlled as well. The Ministry's implementation procedures state (Policy 2 - areas with water quality

not meeting the objectives) that *"all reasonable and practical means be taken to reduce waste loadings"*, and "no further degradation will be permitted". The goal for use of the river for swimming was therefore defined as:

(1) eliminate dry weather pollution sources

(2) reduce wet weather pollution loadings

In view of the experience at Mooney's Bay beach where occasional closings of the beach have occurred during large rainfall events, a target of 10% violations of the swimming standard was suggested by the Medical Officer of Health for use of the river for swimming below Hog's Back. The control measures discussed in the next chapter are aimed at achieving this level of bacteriological water quality.

5.3 RECREATIONAL OPPORTUNITIES

All of the area municipalities, the Region and the Province of Ontario regard the Rideau River as a great natural asset with important recreational features. The NCC and Parks Canada have also recognized the potential of the Rideau River and the Rideau Canal, and they have developed extensive facilities along both. The City of Ottawa has acquired a substantial amount of land along the Rideau River and it should continue its policy of acquiring land as open space as a buffer between urban uses and the River. In addition, the NCC also owns substantial land along the River on which facilities may be developed which do not depend on water contact recreation standards.

The RMOC report "Ottawa and Rideau River Shores in Ottawa-Carleton" (1978) discusses in considerable detail the condition of the Rivers and the recreational facilities along them. It is recognized that the potential of the River can be used for activities which do not require immersion of the body. No comments are made on these aspects here, although they may be construed as major assets.

The matter of swimming on the Rideau River has been a subject of discussion for many years, particularly since the beaches in the lower area were closed. An objective was added to the terms of reference of the RRSMS (objective 10) specifically to identify the swimming needs with respect to the Rideau River and the most practical bathing areas based on the identified swimming needs and existing and predicted water quality of the River. A number of meetings were held with area planning and recreation staff in an attempt to address the question of swimming needs of the population. However, available resources did not permit a specific investigation to be undertaken to establish the demand for River swimming facilities in the Region and, as a result, the demand for beach swimming based on a detailed and comprehensive survey is not available.

The control measures evaluated in this report for the improvement of water quality in the lower reach of the Rideau River involves great expense (see Chapter 6) and achievement of swimming standards can not be guaranteed. Therefore, it is suggested that remedial measures be implemented in a phased approach from Hog's Back to the Rideau Falls. At the end of each phase an economic analysis of the relative merits and cost of meeting swimming standards in the lower areas (Brighton, Brantwood and Strathcona) should be considered. This analysis should include factors effecting bather use and the maintenance and capital costs of such facilities. In addition, input from the communities affected should be addressed.

6. POLLUTION CONTROL MEASURES

This chapter describes control measures and approximate cost for the sources of bacterial pollution outlined in the previous chapter. The control options are discussed according to the source of pollution (dry or wet weather) since the control strategy differs significantly. A prerequisite for meeting bathing standards is that the bacteriological water quality is satisfactory during dry weather. Thereafter, wet weather pollution controls should be considered.

6.1 DRY WEATHER CONTROL MEASURES

6.1.1 Elimination of Leakage from Sanitary Sewers

The analysis has shown that pollution sources appear to exist between Carleton University and the Smyth Road Bridge and, more specifically, in the section of the River between Brewer Park and Windsor Park. The second area of concern is between the Queensway and the Rideau Tennis Club and in particular the area immediately downstream from the Queensway bridges including the bridges themselves. These local pollution sources are thought to originate from directly connected sanitary sewers, leakages from sanitary sewers and sewer cross-connections. Estimates have been prepared for locating and for correcting these sources.

Inspection and repair

Cost estimates have been prepared for inspection with TV equipment at $1.25/m of sewer. The necessary repair or sealing work has been estimated assuming that 10% of all sewer pipe joints would require sealing at a cost of $125/joint; and 2% of the total length of the sewers would need repair by excavation and replacement at a cost of $150/m. An additional 10% of the estimated cost was also added for boring and soil investigations. Summarized by beach, the costs are:

Brewer Park	Brighton Beach	Brantwood Beach	Strathcona Beach
$108,000	$305,000	$100,000	$290,000

It should be pointed out that above estimates are approximate. After TV inspections of the sewers, the actual magnitude of the problem can be determined with more confidence. The effectiveness of corrective action can only be determined by in-stream water quality surveys and continuing monitoring.

Interception and treatment

Some sources may go undetected or resist corrective action. In such cases, the only alternative left open is to physically isolate the River from any subsurface flow contributions. This would involve the construction of interceptors along the River and treatment ponds or other treatment devices. The purpose of the interceptor would be to divert the dry weather flow of storm sewers and contaminated groundwater flow, if any. In an already built environment, this would not be easy to accomplish.

Three options were considered (Report 23) as follows:

OPTION	TYPE OF DESIGN	COST
1	Dry weather interceptor	$ 3,500,000
2	Dry weather ponds	$ 5,000,000
3	Treatment	$ 9,500,000

It was shown earlier that dry and wet weather controls would be necessary to reduce fecal coliform levels to swimming standards. Hence, these dry weather controls alone are not sufficient to meet objectives and they are not considered further. Interception and associated treatment should be designed for both dry and wet weather control, as dicsussed in section 6.2

6.1.2 Control of Pigeons

After the sanitary waste source(s) have been eliminated, and before the Medical Officer of Health's bathing standards can be met, the direct input from pigeons on bridges must be controlled. The diversion of pigeons from bridges involves basically three alternatives:

1. the elimination of the pigeons,
2. the protection of the bridges from roosting by physical barriers (such as screening), and
3. the expulsion of the pigeons from the bridges by chemical, light, sound or other means.

Economic, social, environmental and safety concerns were considered in evaluating the above control alternatives and it was subsequently determined that the expulsion of birds using chemical means would be the preferred option. The chemical must be applied approximately every second year to a bridge at a cost of approximately $2,000.

Summarized by beach these costs over a ten year period are:

Brewer Park	Brighton Beach	Brantwood Beach	Strathcona Beach
$ 20,000	$ 10,000	$ 10,000	$ 20,000

Before a full-scale program of bird control is implemented, it is recommended that the method be tested on a selected bridge. One should also ensure that the displaced bird population does not pollute the River at other locations. New bridges should be designed such that access by birds is minimized.

6.1.3 New Developments

Most of the urban development is expected to occur above Hog's Back. Minimizing potential dry weather sources of pollution to the River in new developments should be stressed. Recent experience has shown that most cross-connections between storm and sanitary sewers are found in new developments. Therefore, it is important that all new sewer connections are duly inspected by the municipality after construction. It is much easier to control pollution at source during construction than to correct old sources or faulty connections in older areas.

The Engineering Consultants (Report 23) recommended for maximum protection of the upstream area, to limit the number of storm sewer

outlets to the River and to provide for end-of-pipe quality polishing facilities for ultimate protection against accidental spills and cross-connections, and for trapping sediment and dirt washed directly off impervious surfaces. In other words, total control of all discharges to the River. This recommendation was based on the possibility of urban development to contaminate surface water through subsurface pathways as inferred in the area below Hog's Back. However, dry weather problems in the Rideau River below Hog's Back appear to originate from leaks in the old sanitary sewers and directly connected sanitary sewers. It is not expected that these problems will emerge in the upstream area with more rigorous construction methods and procedures. Hence, quality polishing facilities would not be required soley for dry weather control, but stormwater treatment ponds can be designed and operated to deal with potential dry weather problems.

Additional measures could be taken to ensure maximum protection of the Rideau River. For example, it was recommended (Report 23) "that a continuous greenway buffer strip should be maintained along the length of the river. The City of Ottawa should continue to acquire land along the Rideau River to serve as an open space corridor between the river and adjacent urban land uses. This buffer greenway will serve to reduce the opportunity for direct surface runoff and uncontrolled point discharges to the river, and maximize the recreational uses of the adjacent lands. It will also provide an opprotunity to retrofit controls in the future with minimum disruption of the built-up areas, should any be required."

6.2 WET WEATHER CONTROL MEASURES

Rainfall and runoff provide the mechanism to move pollutants accumulating on the surface to the drainage system and beyond to the receiving water. In urban areas the accumulation of bacterial pollutants may be ascribed to pets and wildlife. Consequently, pollution levels observed at the end of the sewer system are related to the type of land use and urban population density. Residential areas

are expected in this regard to produce higher pollution levels than commercial areas. A summary of control measures for fecal coliform reduction is given in Table 7. These measures were chosen for their effectiveness from a longer list prepared during Phase I of the Study (Report 15). A short discussion of the most effective measures is given below.

Table 7: Urban Bacteria Control Measures for Reduction of Wash-off of Fecal Coliform

CONTROL MEASURE	CONTROL EFFECTIVENESS (*)	CONTROL COST (RELATIVE)	ENVIRONMENTAL CONCERNS	SOCIAL CONCERNS
Catchbasin cleaning	low	moderate/high	low	low
Street cleaning	low/moderate	moderate/high	low	low
Dog feces control	moderate	low	low	high
Runoff retention and/or treatment	high	high	moderate	moderate

(*) Estimated fecal coliform bacteria reductions in the Rideau River.

6.2.1 Source Controls

Source controls, i.e. upstream of storm sewer inlets are encouraged by regulatory agencies as an effective means of controlling the rate of runoff (see for example: Ontario Ministry of Natural Resources, Central Region (1981), and the American Public Works Association (1981)). The specific source controls discussed below relate to water quality improvement.

Dog feces control

The most obvious control measure would be to reduce the surface deposition. Ottawa, Nepean and Gloucester all have dog control bylaws

regulating the deposition of dog feces. Ottawa, in its bylaw No. 198-81 (passed June 17,1981), requires that dog feces be removed immediately when deposited on city streets, public parks, other public property, and private property (except that of the dog's owner or custodian). Ottawa also prohibits dogs running at large. Nepean passed bylaws No. 32-79 on March 27, 1979, which prohibits dog feces on streets and public parks, unless immediately removed. Gloucester's bylaw No. 108 of 1980 prohibits dogs running at large and dog feces deposited on streets or bridges, town property, or public property (except with authority from the property owner or occupant). Any dog feces deposited on these areas must be immediately removed.

If these regulations were effectively enforced much of the urban runoff fecal coliform discharges would be eliminated, possibly resulting in a 20% decrease in fecal coliform densities in the Rideau River (Report 21). Dog owners should also be encouraged to properly dispose of dog feces deposited on their property. Proper disposal would include placing the feces in a garbage can (properly wrapped) for garbage collection or alternatively, the feces could be composted on site. Although this dog control is relatively inexpensive in monetary terms, major social and political problems may be associated with it. Hence, a choice must be made between the reduction of accumulations at the source versus the cost of treatment at the end of the pipe.

Street cleaning

Street cleaning alone will not achieve bacterial control objectives, although it may be effective in reducing the fecal coliform loadings for many small storms. Cleaning would have a very small effect on the bacteria discharges from the larger storms (greater than 10 mm) which originate from pervious areas, and terminal treatment of stormwater would still be required (Report 21). Other benefits associated with street cleaning such as removal of solids and heavy metals have not been evaluated in the RRSMS.

The extensive street cleaning done now in the downtown area of Ottawa is more than is required for pollution control. If the cleaning

frequencies were reduced from the current nightly street cleaning to cleaning two or three times a week, substantial savings in costs would be realized. The manual litter pickup efforts, however, may have to be increased. The cost savings from reducing the cleaning effort in the downtown areas could be used to increase the cleaning effort in the outlying areas for a better balanced street cleaning program. As a result, it was recommended to increase cleaning frequencies in residential areas to not more than once a week. This would result in reduced street surface loadings for the smaller storms, while enhancing the aesthetic appeal of many areas.

Site Planning

An unavoidable consequence of urbanization is the increase of impervious areas resulting in more frequent loadings of pollutants to the receiving water. Source controls are encouraged to reduce the impact on the receiving water by slowing the rate of runoff and by increasing infiltration.

Cisterns and seepage trenches can be quite effective depending on local soil conditions to reduce the volume rates of runoff and minimize pollution loadings. Proper grading of lots and surface drainage provisions using, for example, swales, will not only benefit water quality but also water quantity problems. These components are all considered to be part of the minor drainage system to be considered at the subdivision design level (Ontario Ministry of Natural Resources, 1981).

6.2.2 Combined Sewer Overflows

One major area is still being served by combined sewers: the Glebe to the west of the Rideau Canal. This area discharges to the Rideau River at Clegg Street downstream of Brantwood Park. A smaller area near Springhurst also discharges to the Rideau River. Both overflows are upstream of Strathcona beach and before swimming will be considered the overflows must be closed to eliminate the discharge of human waste. Closure can be achieved in two ways: sewer separations, or off-line storage and treatment of all flows.

A separate report on the combined sewers (Report 1) concluded that continued sewer separation would be the best long-term solution to protect basements from flooding at a cost of $7,500,000. This program will likely not be completed until 1990.

A number of alternatives to overflow closure were examined for water quality control. An off-line storage facility in Brantwood Park at a cost of $1,500,000 emerged as the only feasible alternative, although this facility would do nothing to solve the basement flooding problems experienced in the Glebe area. Consequently, this lower cost of $1,500 000 has been apportioned for water quality protection (Table 9). The larger proportion of $6,000,000 has been assigned to the other benefits (basement flooding and reduction of flows to the sewage treatment plant) since the City of Ottawa is committed to sewer separation.

The proximity of the Clegg Street combined sewer outfall to Brantwood beach has raised concerns as to the possible impact on water quality of this beach. The outfall is submerged and significant differences water temperature have been measured during the summer months in the river with lower temperatures at depth similar to the temperature of the discharge (Report 15). Hence, upwelling of the discharge plume will be limited and back flow to the beach would only be possible under extreme up-river winds when also the riverflow is near zero. This aspect should be investigated further in Phase II of the pollution abatement program.

6.2.3 Structural Controls Below Hog's Back

Wet weather water quality controls are required below Hog's Back in addition to control of dry weather sources if the River is to be made available for swimming at selected locations. Two control options were evaluated (Report 23).

OPTION	TYPE OF DESIGN	COST
1	Interceptor storm sewers	$11,900,000
2	Stormwater detention and associated piping	$10,200,000

Both options include the interception of the dry weather flow. The interceptors should also be designed to intercept contaminated groundwater flow, if any, thereby physically isolating the River from any surface or subsurface flow contributions.

The size of the interceptors required for option 1 could become excessive if more than a few subcatchments are to be controlled. In addition, overflow structures to the River would be required to ensure that flooding problems are not induced when the interceptor capacity is exceeded. Option 2, detention, is the most cost-effective and is consequently employed further to estimate the cost of the abatement program (Table 9).

6.2.4 Stormwater Treatment

Structural controls at the end of the sewer system before the runoff is discharged into the water course or so-called end-of-pipe facilities, may be designed for various purposes. For water quality control the following are usually considered:

- retention to induce sedimentation and bacteria die-off
- chemical treatment
- disinfection by - chlorination
  - ozonation
  - ultraviolet treatment.

Most of these systems can be designed to any level of treatment required. Of importance, therefore, is the required level of pollution control, local opportunities and the cost of the alternatives.

6.2.4.1 Level of Bacteria Control

The conversion of rural/agricultural lands to urban use will result in an increased frequency of bacteria loadings to the receiving water from the smaller rainfall events due to increased impervious areas and an improved drainage system. Approximately 93% of the rainfall events during the summer months June-August are less than 25 mm. Larger events occur infrequently, and, as outlined before, may generate sufficient fecal loading to the River from uncontrollable areas that a

small percentage of violations of the swimming standard will occur anyway. Therefore, bacteria control is most effective for storms less than 25 mm. Water quality controls should be incorporated in new developments to control new sewer outlets and to ensure that in-stream violations do not increase. Guidelines should be prepared which specify, among other things, the allowable release rates after development recognizing the River's assimilative capacity.

Various retention basins have been constructed in the RMOC to reduce pollution loadings to the Rideau River (Figure 14). The Kennedy-Burnett Pond in the City of Nepean has been the subject of intensive and detailed study over the last few years (Report 10). This retention pond has shown that water quality control to the level outlined above is feasible by settling alone. Results from this study should be used in the preparation of the design guidelines and these guidelines should be updated when additional information becomes available from future monitoring of other stormwater treatment facilities.

Controlling rainfall events up to 25 mm requires a stormwater pond volume equivalent to 5 to 10 mm of runoff depending on the anticipated land use characteristics and specifically the per cent imperviousness. The volume given above does not consider any on-site runoff controls and, hence, an optimization of controls (on-site or end-of-pipe) should be considered at the design stage. By-passes or overflows of any structure should not be more than four times over the 3 month period June-August in an average year. Since settling ponds can provide the required treatment, future stormwater control costs are based on this type of design only (see section 6.2.4.4)

6.2.4.2 Kennedy-Burnett Settling Pond

The Kennedy-Burnett stormwater runoff treatment pond is located in the developing area of Barrhaven in the City of Nepean. The pond was constructed in 1976 and presently serves as a settling basin for 60 hectares of developing area. The volume of the pond is 25,000 cu. meters, it has a length of 422 m, a bottom width of 18 m (concrete) and

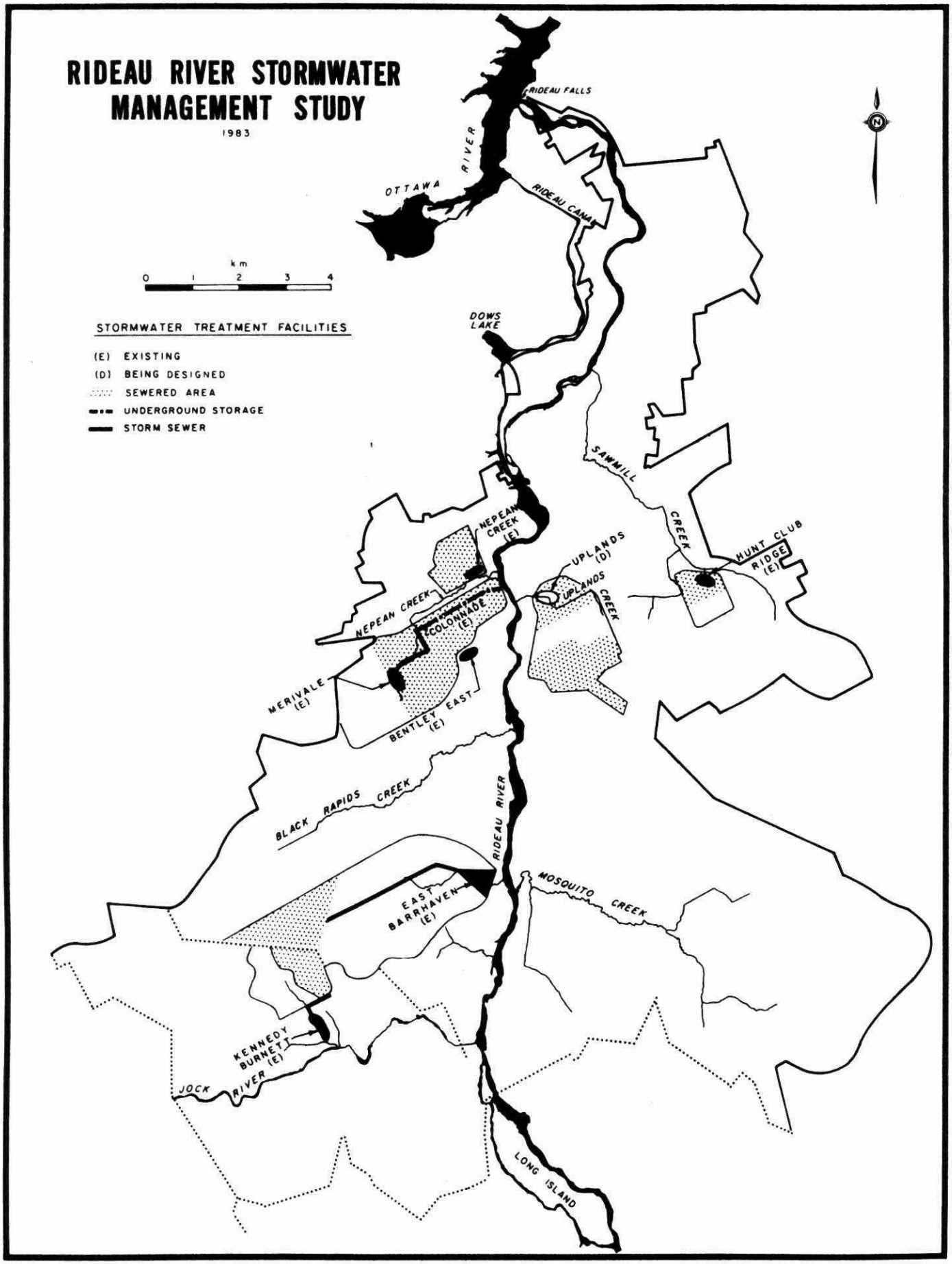


Figure 14: Stormwater treatment facilities

a trapezoidal cross-section with a top width of 31 m. The pond is designed to ultimately contain the runoff from an area of 160 hectares and a rainfall of 35 mm (over 2 hours) before discharge of the stormwater into the Jock River, a tributary to the Rideau River. The pond is designed for batch treatment (fill and draw). The pond storage is equivalent to a runoff volume of about 15 mm.

Operating mode

During the study the pond was operated in the batch mode and in the continuous flow mode by keeping a minimal volume in the pond and leaving the outlet pipes open. This was done to obtain information on the effectiveness of the pond in both modes of operation. In batch mode of operation, runoff was stored for three days before being discharged. For many very small events the retention time was even longer. Since the volume is oversized for the area presently served, runoff from rainfall events up to 90 mm can be contained.

Mixing

Runoff pollutants were observed to travel the length of the pond in zones of high concentration. Whenever these zones reached the discharge end of the pond without sufficient mixing or decay in continuous flow mode, the effluent concentration would be higher than corresponding effluent from the batch mode where a longer retention time was provided and better mixing occurred.

Performance

Performance was evaluated by measuring pond input loads and effluent loads and determining the per cent removal for various events. Water quality parameters investigated were biochemical oxygen demand (BOD), dissolved oxygen (D.O.), total and dissolved phosphorus, nitrogen species, fecal coliform, fecal streptococcus and Pseudomonas Aeruginosa.

It was found that after 16 hours of settling, up to 90% removal of suspended solids and total phosphorus was possible. Small-scale trials using ferric chloride reduced the settling time to two hours and

increased removal by 5%. Chemical flocculation on a small scale also appeared to significantly reduce the numbers of fecal coliforms.

Fecal coliform growth was observed in runoff samples but only after sufficient time had elapsed to settle out most of the suspended solids. Observed growth was an order of magnitude which took about 10 to 12 hours after which the numbers decayed at the rate of about 0.098/hr or an equivalent T_{90} time of 30 hours.

The Kennedy-Burnett treatment pond in batch mode for both single runoff events and on a seasonal basis, was found to be effective in removing stormwater loads of suspended solids and fecal coliforms exceeding 95% and fecal streptococci in excess of 85%; BOD removal was less than 50%. The performance in continuous mode was less on a seasonal and on a single event basis, although rainfall events less than 12 mm received approximately the same amount of treatment.

The study has provided valuable information on operating procedures for the Kennedy-Burnett Pond and, in addition, provided some insight into the processes taking place in the pond itself. The results are documented in a separate report (#10) and are valuable for the design of future runoff treatment facilities as various combinations of runoff treatment are considered (volume, size, flocculation, disinfection). These aspects must be optimized for a specific site given pond effluent criteria, receiving water objectives and local opportunities as the capital investment in stormwater treatment facilities is substantial.

6.2.4.3 Disinfection

Effluent disinfection techniques have not been the subject of detailed investigations by the Rideau River Stormwater Management Study. However, they definitely have a role to play in the development of a pollution control strategy as they may be applied on a very site specific basis wherever required.

A limited investigation was carried out of the feasibility of using ultraviolet light (Report 13) for the disinfection of Rideau River

water. The technique has potential for disinfecting a selected portion of the flow of the River near a beach and, consequently, could be used as a means of ensuring appropriate quality of water at a specific site independent of river water quality.

6.2.4.4 Treatment Cost

A combination of controls is normally employed in the development of a subdivision making maximum use of local opportunities. However, retention ponds have shown that water quality control to the level required is feasible by settling alone, and, hence, costs given here are based on this type of pond.

The capital cost of treatment ponds contructed in the RMOC varies from $2,000 to over $8,000/ha depending on the total area served, local opportunities and land costs (Table 8). Based on an average cost of $4,000/ha, pollution control by settling alone in the developing area is estimated at $10,000,000, mainly in the South Urban Community. Considering such an outlay for future controls, it appears appropriate to invest resources now in an assessment of facilities to develop cost-effective designs.

At the start of the study little was known about the performance of settling ponds and as a result some of the facilities constructed to date may have been overly conservative in design for maximum water quality protection. In addition, all facilities constructed to date are unique and provide a largely unknown level of pollution control as a function of their design. Hence, treatment facilities other than the Kennedy-Burnett pond should be monitored by the RMOC to establish a suitable data base for future designs.

Developments in the lower Rideau River basin in the Regional Municipality of Ottawa-Carleton are pioneering the control of bacteriological pollutants to protect the recreational use of the receiving water. Many stormwater control facilities have been built in Canada and elsewhere, although most are designed to control erosion or flooding rather than bacteriological pollution. Therefore, the

Table 8. Estimated pollution control cost for developing areas.

River Reach	Catchment No.	Total area (ha)	EXISTING CONTROLS Location	Area	Cost/ha	Future Development (ha)	Future Controls (@$4,000/ha)
Sawmill Creek	8	2336	Hunt Club Pond	61	2,000	68	272,000
	15	316				7	
Hog's Back	16	255				0	
to	17	351	Nepean Creek	31	5,900	16	
Black Rapids	18	574	Colonnade super pipe Merivale Pond	526	2,000	17	1,244,000
	19	383				55	
	20	544				216	
Greenbelt	21	1595				0	
	22	1094				0	
	23	942	E. Barrhaven	345	2,700	468	
South Urban	24	3758				827	
Community	25	436				0	8,464,000
	26	2969	Kennedy-Burnett	160	8,200	788	
	27	828				33	

Total expenditures to date: $ 5,200,000 (in 1983 dollars)

Future estimated expenditure: $10,000,000 (over a period of 20 years)

planning, design and operation of stormwater pollution controls should be approached with an integrated strategy providing feedback until proceduces are standardized.

6.3 SUMMARY OF CONTROL MEASURES

A comprehensive list of pollution control measures was compiled and all options were screened for their effectiveness in Phase I of the study (Report 15). A limited number were considered in more detail in Phase II/III of the study as described in the previous sections. Summarized by impact they are:

FOR DRY WEATHER POLLUTION CONTROL:

Source of pollution	Control Measure	Estimated Cost
Leakage from sanitary sewers	. Sealing/repair of leaks	$ 803,000
	. Flow interception and treatment*	$10,200,000
Pigeons on bridges	. Expulsion by paint	$ 60,000

* Dry and wet weather - including $1 million for Sawmill CK

The elimination of leakage of sanitary waste to the River is considered to be very effective. However, the exact sources have not been located and therefore, the magnitude of the problem and the effectiveness of abatement measures are largely undetermined. Structural controls by interception, diversion and treatment should be effective if the River can be isolated from the urban environment. Costs are approximate only.

The elimination of pigeons appears to be possible at a reasonable cost, although the effectiveness of the control measure has not been tested locally.

FOR WET WEATHER POLLUTION SOURCES (URBAN RUNOFF)

Sources of Pollution	Control Measure	Estimated Cost
Wash-off of dog feces and other animal droppings	. Enforcing and strengthening bylaws incl. proper disposal	N.A.
	. Street sweeping	N.A.
	. Run-off treatment/ disinfection	$ 4,000/ha
Combined sewer overflows (2)	. Sewer separation	$7,500,000
	. Off-line storage	$1,500,000

Bacteriological pollution from urban runoff could largely be eliminated if the sources of pollution were removed or feces contained and disposed of properly. Strengthening of dog control bylaws and street cleaning will reduce overall catchment loadings to the Rideau River but they will not be sufficient to achieve objectives. Therefore, some form of stormwater treatment would still be required if swimming is desirable. Reduction of pollution at the source would still have an overall beneficial effect which may be achieved at minimal cost.

Combined sewer overflows must be eliminated if the River is to be made available for swimming. The necessary pollution controls are summarized by beach below Hog's Back in Table 9.

The approximate cost of controls in the upper reach from Hog's Back to Long Island may be summarized assuming unit costs of $4,000/ha for future developing areas as shown in Table 10.

Table 9. Pollution control measures and their incremental costs for achieving acceptable water quality at selected beach location below Hog's Back ($1,000's)

TYPE OF CONTROL	PHASE I	PHASE II		PHASE III	
	BREWER PARK	BRIGHTON BEACH	BRANTWOOD BEACH	STRATHCONA BEACH	TOTAL COST
Elimination of leakage from sanitary sewers	108	305	100	290	803
Control of pigeons (***)	20	10	10	20	60
Flow interceptors and treatment (existing development)	(1,200)*	3,600	1,400	5,500**	10,500 (11,700)*
Stormwater treatment (future development in Sawmill Creek)	-	272	-	-	272
TOTAL ESTIMATED COST	128 (1,323)*	4,187	1,510	5,810	11,635 (12,835)*

* to be carried out only if control of leakages are ineffective or too expensive

** including $1,500,000 for the area presently served by combined sewers as an apportioned cost for water quality benefits

*** over ten-year period

Table 10. Cost of stormwater runoff quality controls above Hog's Back ($1,000's, 1983 dollars)

AREA	EXISTING	FUTURE	TOTAL COST
Mooney's Bay to Black Rapids	1,660	1,200	2,860
Black Rapids to Long Island	3,540	8,500	12,040
TOTAL COST	5,200	9,700	14,900

7 REFERENCES

7.1 STUDY REPORTS

	DESCRIPTION	DATE	STATUS
	BY COOPERATING AGENCIES		
	City of Ottawa		
1.	COMBINED SEWER OVERFLOW STUDY, Technical Report and Executive Summary (2 vols.) by M.M. Dillon Ltd.	Oct/81	*
	Environment Canada		
2.	STORMWATER MONITORING STUDY: RIDEAU RIVER, NATIONAL CAPITAL AREA, 1978 (2 vols.), Report No. OR-24 by Laboratory Services, EPS, Ontario Region	Dec/78	
3.	RIDEAU RIVER WATER QUALITY AND STORMWATER MONITOR STUDY, 1979, MS Report No. OR-29 by Laboratory Services, EPS, Ontario Region	Feb/80	
4.	RIDEAU RIVER WATER QUALITY AND STORMWATER MONITORING REPORT, 1980 by Laboratory Services, EPS, Ontario Region	Mar/82	
5.	SUMMARY REPORT ON THE KENNEDY-BURNETT MODELLING STUDY, by J. Marselek, NWRI	Aug/82	*
	Regional Municipality of Ottawa-Carleton		
6.	STUDY PLAN FOR THE KENNEDY-BURNETT STORMWATER RUNOFF TREATMENT STUDY by R. J. Gietz, Works Department	Oct/80	*
7.	RIDEAU RIVER BRIDGES, PIGEON POPULATION - DAILY LOAD OF FECES by J. Barnwell, Works Department	Nov/80	*
8.	KENNEDY-BURNETT STORMWATER RUNOFF TREATMENT STUDY, FIRST ANNUAL REPORT, 1979-80 by R. J. Gietz, Works Department	Mar/81	

	DESCRIPTION	DATE	STATUS
9.	KENNEDY-BURNETT STORMWATER RUNOFF TREATMENT STUDY, SECOND ANNUAL REPORT, 1980-81 by R. J. Gietz, Works Department	Jun/82	
10.	URBAN RUNOFF TREATMENT IN THE KENNEDY-BURNETT SETTLING POND by R. J. Gietz, Works Department	Mar/83	
	Ontario Ministry of the Environment		
11.	WATER QUALITY SUMMARY, RIDEAU RIVER, 1974-1975, G. Owen, Kingston	Dec/79	*
12.	RIDEAU RIVER STORMWATER STUDY by A. Burger, M. Young, L. Vlassoff, Microbiology Section, Toronto	Oct/82	*
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	BY CONSULTANTS ON CONTRACT		
14.	EVALUATION OF OXYGEN DEMAND PHENOMENA TRANSPORT, AND INDICATOR BACTERIA SURVIVAL IN THE RIDEAU RIVER, by R. Droste & K. Adamowski, University of Ottawa	Sep/80	*
15.	RIDEAU RIVER PHASE I STUDY, Technical Report and Executive Summary (2 vols.) by Gore & Storrie Ltd./Proctor & Redfern Ltd.	Apr/81	
16.	INDICATOR BACTERIA DIE-OFF IN THE RIDEAU RIVER, R.L. Droste & A.I. Gupgupoglu, University of Ottawa	Jul/81	
17.	HOURLY RAINFALL STATISTICS FOR CANADA DEPARTMENT OF AGRICULTURE STATION, OTTAWA 1960-1980, APRIL-NOVEMBER by Gore & Storrie Limited	Oct/81	*
18.	DYE DISPERSION STUDY, AUG-SEP/81, by Gore & Storrie Ltd./Proctor & Redfern Ltd.	Jan/82	*

	DESCRIPTION	DATE	STATUS
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APPENDICES

A: COMMITTEE REPRESENTATION

B: SWIMMING AND BATHING USE OF WATER

C: DRAFT STORMWATER MANAGEMENT POLICY FOR THE REGIONAL MUNICIPALITY OF OTTAWA-CARLETON

APPENDIX A

COMMITTEE REPRESENTATION BY PARTICIPATING AGENCIES
FOR DURATION OF STUDY (UNLESS OTHERWISE SPECIFIED)

STEERING COMMITTEE

Member	Function/Branch	Period
	MINISTRY OF THE ENVIRONMENT	
R.E. Moore (Chairman)	Director, Southeastern Region, Kingston	
R.A. Dunn	District Officer, Southeastern Region, Ottawa	
S. Salbach	Supervisor, Water Resources, Toronto	
N. Borodczak	) Manager, Environ. Approvals, Toronto	Apr/81 to end
J.R. McMurray	) Manager, Environ. Approvals, Toronto	Jun/79 to Jan/81
P. Seto	) Section Head, Pollution Control, Toronto	Nov/80 to end
G. Van Fleet	) Supervisor, Pollution Control, Toronto	Nov/79 to Nov/80
P. Seto	) Section Head, Pollution Control, Toronto	Jun/79 to Oct/79
	ENVIRONMENT CANADA	
D. Cameron	) Operations Manager, EPS, Ontario Region,	Nov/80 to end
L. Kamp	) National Cap. Area	Jun/79 to Nov/80
W.J. Traversy	Director, Water Quality Branch, IWD	
D. Ballinger	) Area Manager, Parks Canada, Rideau Canal	Nov/81 to end
R. Day	) Area Manager, Parks Canada, Rideau Canal	Nov/80 to Nov/81
L. Doupe	) A/Super., Parks Canada, Rideau Canal	Jun/79 to Nov/80
	REGIONAL AND MUNICIPAL GOVERNMENTS	
F. Ayers	) Commissioner, Works Department, RMOC	Nov/81 to end
W.L. Keay	) Director, Works Department, RMOC	Jun/79 to Nov/81
J. Dempsey	) Chief Engineer, Phys. Environ., City of Ottawa	Jan/81 to end
D. Donaldson	) Director, Phys. Environ., City of Ottawa	Jun/79 to Dec/80
D. Atkins	) Manager, Works Dept., City of Nepean	Jan/81 to end
R. Norton	) Manager, Works Dept., City of Nepean	Jun/79 to Jan/81
J.F. Bockstael	Director, Works Dept., City of Gloucester	

Committee representation (cont'd)

Member	Function/Branch	Period
	MINISTRY OF NATURAL RESOURCES	
J. Anderson)	Deputy Regional Director, Eastern Region,	Aug/82 to end
S.R. Hamilton)	Kemptville	Jun/79 to Aug/82
	NATIONAL CAPITAL COMMISSION	
R. MacDonald	Chief Engineer, Development	
	OTTAWA-CARLETON REGIONAL HEALTH UNIT	
J. Goold	Chief Inspector, Regional Health Unit	
	RIDEAU VALLEY CONSERVATION AUTHORITY	
O. Stirajs	Resources Manager, Manotick	
	RIDEAU RIVER STORMWATER MANAGEMENT STUDY	
H.S. Loijens** (Secretary)	Coordinator, RRSMS	
	FINANCIAL COMMITTEE	
D. Weatherbe*	Section Head, Water Resources, MOE Toronto	
F. Ayers)	Commissioner, Works Department, RMOC	Nov/81 to end
W.L. Keay)	Director, Works Department, RMOC	Jun/79 to Nov/81
(Chairman))		
J. Dempsey)	Chief Engineer, Phys. Environ., City of Ottawa	Jan/81 to end
D. Donaldson)	Director, Phys. Environ., City of Ottawa	Jun/79 to Jan/81
	INTERIM POLICY COMMITTEE	
R.A. Dunn	District Officer, Southeastern Region, MOE	

*Mr. Weatherbe was designated MOE Liaison Officer and sat as an observer, as well as an alternate, on the Steering and Technical Committees.
**Mr. Loijens, Study Coordinator, was ex-officio a member on all Committees.

Committee representation (cont'd)

TECHNICAL COMMITTEE

Member	Function/Branch	Period
	MINISTRY OF THE ENVIRONMENT	
G. Zukovs	) Project Manager, Pollution Control, Toronto	Dec/80 to end
P. Seto	) Section Head, Pollution Control, Toronto	Nov/79 to Nov/80
F.A. Tonelli	) Project Manager, Pollution Control, Toronto	Jun/79 to Nov/79
	ENVIRONMENT CANADA	
D. Cameron	) Operations Manager, EPS, Ontario Region,	Nov/80 to end
L. Kamp	) National Cap. Area	Jun/79 to Nov/80
	REGIONAL AND MUNICIPAL GOVERNMENTS	
R.J. Gietz (Chairman)	Chemist, Pollution Control Centre, RMOC	
J. Simmonds	) Senior Engineer, City of Ottawa	Jan/81 to end
J. Dempsey	) Chief Engineer, City of Ottawa	Jun/79 to Dec/80
D. Atkins	) Manager, Works Dept., City of Nepean	Jan/81 to end
R. Norton	) Manager, Works Dept., City of Nepean	Jun/79 to Oct/81

Committee representation (cont'd)

TECHNICAL SUBCOMMITTEES

Member	Agency	Period
Water Quality Criteria		
M. German (Chairman)	Water Quality Assessment, MOE, Kingston	Mar/81 to end
J.R. McMurray (Chairman)	Approvals, MOE, Toronto	Aug/79 to Jan/81
Water Quality Data		
R. Toxopeus)	Environment Canada, EPS	Aug/80 to May/82
A. Tennant)	Environment Canada, EPS	Jun/79 to Jul/80
S. Whitlow	Environment Canada, ECS (NAQUADAT)	Jan/80 to end
R.J. Gietz	Chemist, RMOC	
H.S. Loijens (Chairman)	Coordinator, RRSMS	
Kennedy-Burnett		
W. Wong)	Pollution Control, MOE	Mar/81 to end
G. Zukovs)	Pollution Control, MOE	Dec/79 to Mar/81
J. Marsalek	Environment Canada, NWRI	
R. Toxopeus)	Environment Canada, EPS	Aug/80 to May/82 A.
A. Tennant)	Environment Canada, EPS	Dec/79 to Jul/80
R.J. Gietz (Chairman)	RMOC	
River Bathing Needs		
H.S. Loijens (Interim Chairman)	RRSMS Coordinator	Aug/80 to Dec/80
R. Norton (Chairman)	Works Department, City of Nepean	Dec/79 to Jul/80

APPENDIX B

SWIMMING AND BATHING USE OF WATER

Excerpt from: WATER MANAGEMENT - Goals, Policies, Objectives and Implementation Procedures of the Ontario Ministry of the Environment, November 1978.

Aesthetics

Water used for swimming, bathing and other recreational activities should be aesthetically pleasing. The water should be devoid of debris, oil, scum and any substance which would produce an objectionable deposit, colour, odor, taste or turbidity.

Discharge of Waste Materials

Discharge of waste and offensive materials due to land drainage or due to direct application to the water body must be curtailed or controlled in order to maintain recreational usage.

pH

Because both alkaline and acid waters may cause eye irritation, the pH of the water used for recreational purposes should be within the range of 6.5 and 8.5.

Public Health Considerations

The use of water for swimming, bathing and other recreational activities requiring immersion of the user should not cause disease(s) or infection(s) in the human user. Such disease(s), which may occur in the gastro-intestinal tract, the eye, ear, nose or throat or in the skin, could be caused by pathogens including bacteria, fungi, protozoa or viruses contained in the water.

A potential health hazard is defined as a situation where there is a high risk of contracting a disease from use of the water. In these situations: confirmation of the hazard should be sought; potential users should be notified by the appropriate authority; immediate corrective action should be started; and surveillance of the water quality should continue until the corrective action is completed and the water quality can be declared safe for recreational use.

Water quality impairment is defined as a situation where there is a risk of disease from use of the water but where a less restrictive course of action can be followed. In these situations: confirmation of the impairment should be sought; corrective action should be started; and surveillance of the water quality should be maintained.

Because inadequately treated sewage and fecal matter are a primary source of disease-causing organisms, a potential health hazard exists if a sanitary survey discloses that inadequately treated sewage, fecal matter or other hazardous substances are being or may be discharged

into the water. The sanitary survey should consist of an on-site inspection of adjacent and upstream areas and of all water flows and potential sources of discharge. The survey should take into account the effects of rainfall, peak user loads, the danger of accidental spillage and sources from other jurisdictions.

Because epidemiological data and outbreak reports are a direct measure of the risk of contracting a disease, a potential health hazard exists when such information (available to the Medical Officer of Health or other appropriate health authority) discloses the presence, within the community served, of an infectious disease which may be spread or is being spread by the use of the water for recreational purposes.

Because the occurrence of disease-causing organisms is being measured directly, a potential health hazard exists when pathogenic organisms (e.g. Pseudomonas aeruginosa, Salmonella typhii and Polio virus) can be enumerated and frequently isolated from the water.

Bacteriological water quality indicators are groups of bacteria whose densities in water can be related quantitatively to the presence of sewage or fecal matter, and therefore to the risk of contracting a disease from pathogens contained therein. The fecal coliforms are one of these indicators. A potential health hazard exists if the fecal coliform geometric mean density for a series of water samples exceeds 100 per 100 ml.

The total coliforms are also water quality indicators. However, increasing evidence suggests that the total coliform group can also be derived from sources other than sewage and fecal matter. Therefore, water quality is considered impaired when the total coliform geometric means density for a series of water samples exceeds 1000 per 100 ml.

The fecal streptococci are yet another water quality indicator. However, they can best be used in conjunction with the fecal coliforms as an indication of the nature of the potential fecal source. If the ratio of the geometric mean densities of the fecal coliforms to fecal streptococci at the point of discharge exceeds 4, the source of the discharge is likely to be human in origin. A ratio of less than 0.7 suggests that the source is probably of non-human origin. Ratios between these values are difficult to interpret and may indeed be mixtures. For reliable ratio data, the fecal coliform density should approach or exceed 100 per 100 ml. The ratio must be applied carefully as numerous environmental factors will influence the densities of both of these organisms.

Other groups of bacteria (e.g. Pseudomonas, Staphylococcus) could provide better information concerning the risk of eye, ear, nose, throat and skin infections since these organisms may be indicators of the presence of the causative agents for these diseases.

Sampling

Water samples for bacteriological examination must be collected in sterile bottles under aseptic conditions. Because the water samples

are highly perishable, the samples should be kept cool or refrigerated and bacteriological analyses of the samples should be done within 6 hours. The time elapsing between collection and the start of examination in the laboratory should not exceed 24 hours.

A series of at least 10 samples per month per sampling location is recommended, but an increased sampling frequency will be required when the water is used for recreational purposes or when the water is subjected to contamination or discharge.

APPENDIX C

DRAFT STORMWATER MANAGEMENT POLICY FOR THE REGIONAL MUNICIPALITY OF OTTAWA-CARLETON

In pursuit of the general policies set out in this section, it is the policy of the Regional Municipality, in conjunction with Area Municipalities, to practice and encourage effective measures for the management of stormwater quality and quantity in the Region in order to control flooding, erosion, sedimentation and pollution on and in the water courses in the Region and to enhance their aesthetic and recreational potential.

To implement this policy, the Region may require the preparation and adoption of a MASTER DRAINAGE PLAN for any area prior to the approval of new development therein.

For the purposes of this section, a Master Drainage Plan shall mean a document prescribing an appropriate drainage system for a watershed, the ways in which water quality, flooding and channel erosion problems may be avoided in the future and existing problems remedied. A Master Drainage Plan shall include any matter which Council feels necessary for the catchment or drainage area to which it pertains:

1. to ensure the safety and health of the general population;

2. to reduce property damage to a minimum;

3. to mitigate the impact of proposed development or redevelopment on the environment; and

4. to remedy existing problems.

It is the policy of the Region to ensure that appropriate stormwater management facilities be constructed and thereafter satisfactorily

operated and maintained. To this end the Region will consult with Area Municipalities and will adopt more detailed guidelines and criteria and will make administrative and financial arrangements with the Area Municipalities to achieve effective stormwater management.

The Regional Council or the Council of an Area Municipality, as may be appropriate, may pass by-laws, acquire lands, undertake public works, impose, or request an Area Municipality to impose, appropriate conditions of approval on draft plans of proposed subdivision/ condominium and site plans, or otherwise facilitate or encourage effective stormwater management, in accordance with Master Drainage Plans where such exist. The Regional Council may, by amending this Plan, or if appropriate the Council of an Area Municipality may by Amendment to its Official Plan, adopt additional policies and guidelines that the Region and/or Area Municipality deem necessary to ensure effective stormwater management throughout the Region.

It is the policy of the Region to require that the design of DRAFT PLANS OF SUBDIVISION/CONDOMINIUM implement any Master Drainage Plan for the area in which it is situated and if such Drainage Plan has not yet been prepared, the development application be in accordance with sound principles of effective stormwater management. For these purposes the Region or other authorized approval authority shall require the applicant for approval of a draft plan to submit any or all of the following information in support of such application which may include as appropriate:

(1) a plan for the control of erosion and sedimentation on any construction sites as they affect any watercourse or existing stormwater management facility within the boundaries of the draft plan or downstream from the boundaries;

(2) the applicant's proposals for the provision of stormwater drainage facilities in both the major and minor drainage systems as set out in the Provincial Government's paper:

"Implementation of Urban Drainage Policies in Ontario", required to accommodate the development proposed in the draft plan;

(3) the applicant's assessment of the impact on the receiving watercourse(s) or existing stormwater management facility in respect of water quality and quantity, erosion, groundwater infiltration and water levels; and

(4) the applicant's proposals for mitigating any water quality degradation if such is likely to result from the development proposed in the draft plan.

Unless:

(1) existing stormwater management facilities are, in the opinion of the Region, or in the case of Site Plan approval the Area Municipality, after consultation with appropriate approval agencies, adequate to accommodate the anticipated increase in runoff and pollution loadings; or

(2) the applicant has demonstrated to the satisfaction of the Region, or in the case of Site Plan approval the Area Municipality, and appropriate approval agencies that any increase in stormwater runoff likely to result from the proposed development or redevelopment will not materially contribute to downstream flooding, erosion hazards, sedimentation or water quality degradation.

It is the policy of the Region that SITE PLANS, for which approval is requested pursuant to Section 40 of the Planning Act, be evaluated by Area Municipalities on the same basis as that required by this section for Draft Plans of Subdivision/ Condominium.

GLOSSARY

Criterion (water quality)	-	a designated concentration of a constituent, based on scientific judgments that, when not exceeded, will protect an organism, a community of organisms or a prescribed water use with an adequate degree of safety.
Guideline	-	any suggestion, rule, etc., that guides or directs.
Master Drainage Plan	-	a comprehensive plan for a drainage area which through analysis of post-development conditions and evaluations of existing constraints will guide an agency or municipality in those matters effecting drainage and pollution control.
Objective	-	a goal or aim towards which to strive; it may represent an ideal condition that is difficult, if not impossible, to attain economically or technically.
Regulation	-	a specific law that legally applies in all relevant situations.
Standard	-	anything, as a rule or principle, that is used as a basis for judgment, comparison or measure.
Stormwater Management Plan	-	a specific plan for an area to control stormwater runoff quantity and quality to achieve specific objectives.
Watershed Plan	-	a plan for an entire drainage basin which defines all flood lines, flood damage areas, areas of erosion and bank instability and the effect of urbanization on flow and water quality.

RIDEAU RIVER STORMWATER MANAGEMENT STUDY

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LEGEND

LAND USE
- COMMERCIAL, INSTITUTIONAL, INDUST.
- RECREATION
- MAINTAINED OPEN SPACE
- RESIDENTIAL
- SOUTH URBAN COMMUNITY
- AGRICULTURE, OPEN, VACANT

OTHER
- (22) CATCHMENT NUMBER
- STORMWATER TREATMENT

OTTAWA RIVER
RIDEAU FALLS
RIDEAU CANAL
ST. LAURENT
TENNIS CLUB
RIDEAU ST.
STRATHCONA BEACH
QUEENSWAY
BRONSON
BANK
CLEGG ST.
BRANTWOOD BEACH
BLVD.
BRIGHTON BEACH
SMYTH
DOWS LAKE
GLEBE
WINDSOR PARK
BREWER PARK
CARLETON UNIVERSITY
AVE.
WALKLEY
RD.
SAWMILL CREEK
MOONEY'S BAY BEACH
AIRPORT
PARKWAY
BASELINE
NEPEAN
COLONNADE
UPLANDS
HUNT CLUB RIDGE
NEPEAN CREEK
BENTLEY EAST
HWY. 16
GREENBANK
MERIVALE
BLACK RAPIDS
MOODIE
GREENBELT
BLACK RAPIDS CREEK
RIDEAU RIVER
EAST BARRHAVEN
MOSQUITO CREEK
DR.
KENNEDY BURNETT
CARLETON LODGE
REG.
JOCK RIVER
MANOTICK
LONG ISLAND

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